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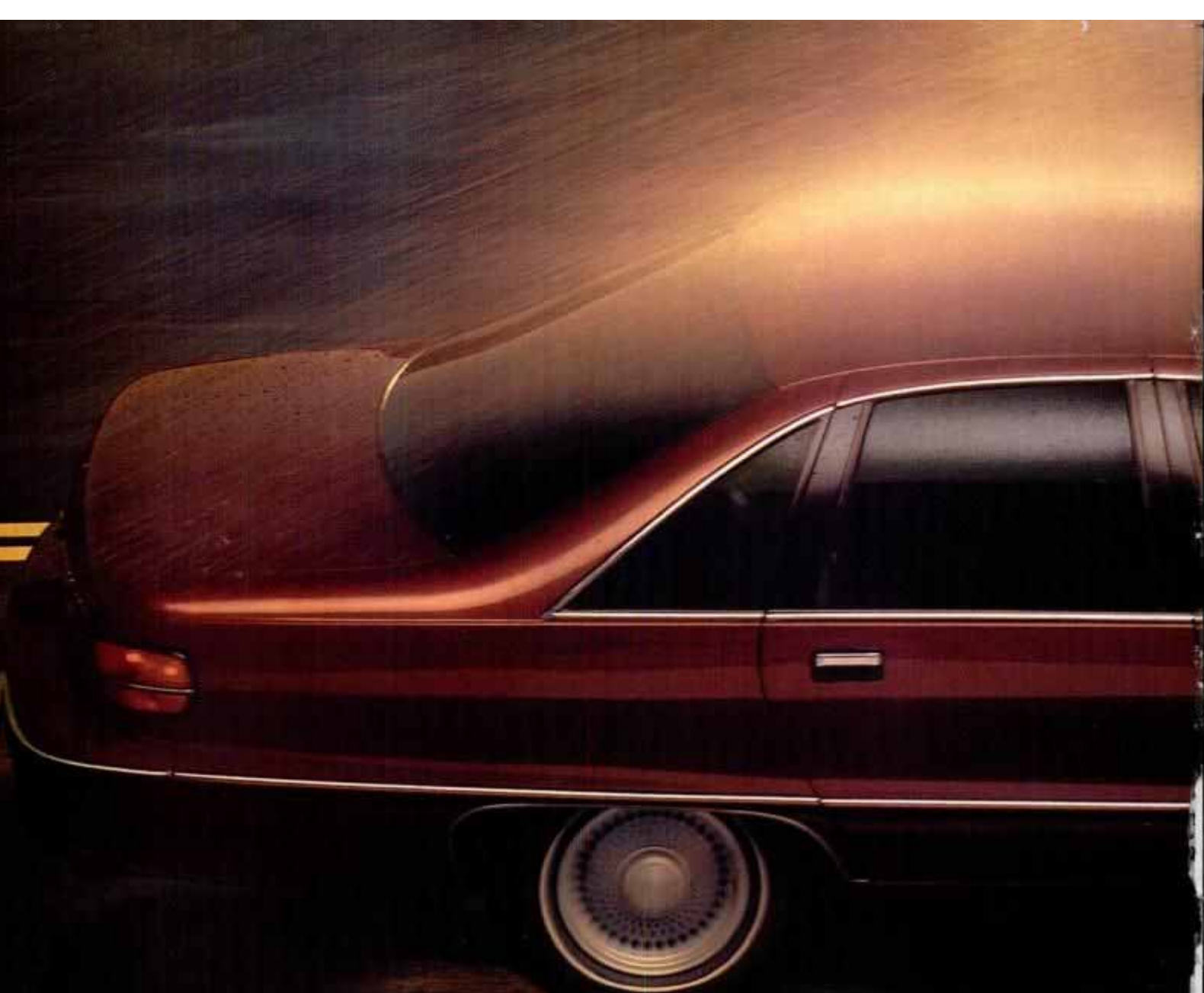
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The 1991 Chevrolet Caprice. It

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The 1991 Caprice is designed to ride as great as it looks. From the drawing board on, it was planned with your comfort and security in mind. It contains **more standard features** than many cars costing much more.

Caprice comes with a



full perimeter frame of carbon steel. The passenger compartment has a rigid cage structure and the doors are reinforced with side-guard door beams.

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stops as beautifully as it looks.



A driver's-side **Supplemental Inflatable Restraint System** is also standard on every Caprice. This "air bag" is designed to inflate in higher-speed frontal crashes and can provide restraint in addition to

the lap and shoulder safety belt.

The traditional road-car ride of V8-powered rear-wheel drive is standard too. Along with many other features designed for security and comfort.

Of course the best way to appreciate any design is to see it for yourself. That's why we invite you to test drive the impres-

sive 1991 Chevrolet Caprice today. And come to your own beautiful conclusions.

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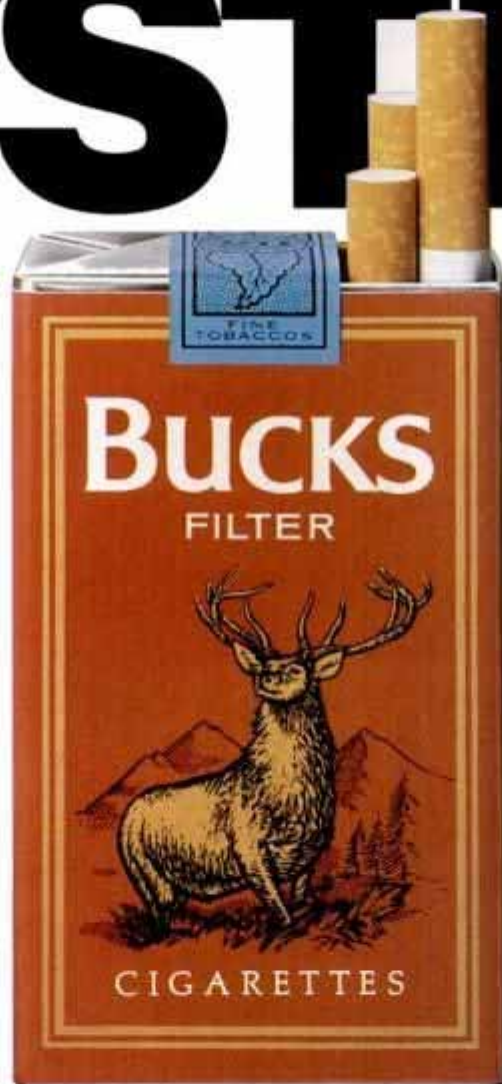
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NO. 11



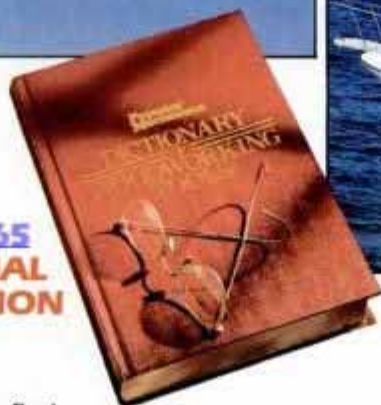
56



60

39 COVER STORY

—PM cover illustration by
Attila Hejja



65
SPECIAL
SECTION

AUTOMOBILES

43 The Iacocca Challenge

Readers take the blind taste test to find out whether they really prefer Japanese-branded cars.

56 Long-Term Test Cars

The Chevy Blazer and Caprice, Pontiac Trans Sport and Honda Accord EX join our fleet.

98 Car Clinic

 Answers to your questions.

102 Imports

 Burning up the autobahn in BMW's new 12-cylinder 850i.

112 Detroit Spy Report

 Ford ups the horsepower for its 1992 Marquis and Crown Vic. Plus a Viper update, Jeeps for Dodge and much more.

127 Saturday Mechanic

 Curing driveline vibrations.

136 Drive Report: GM's New Saturn

The first drive in a production car.

HOME/SHOP

65 SPECIAL SECTION

Dictionary Of Woodworking Tools

A complete reference guide to tools and how to use them.

122 Old House Restoration

 Looking at new items from the restoration bookshelf.

BOATING/OUTDOORS

60 Running The Intracoastal Waterway

A 1500-mile adventure from Miami to New York.

106 Outdoors

 Driftnetting threatens marine life.

SCIENCE/TECHNOLOGY

29 Tech Update Video Tumor Fighter prototype nears completion; Solar-powered cars gear up for a marathon; Navy's top-secret A-12 strike plane; Building the B-2; and more.

39 The Grumman F-14A Tomcat

America's enforcer was more than prepared for the latest Middle East crisis. Here's a firsthand look at our frontline fighter.

48 New Gas: Hype Or Hope?

Higher octane. More detergents. Cleaner burning. That's what the oil companies say is going into your fuel tank.

110 Science

 Is your computer monitor killing you?

132 Aviation

 Piloting one of the last of the historic Supermarine Spitfires.

ELECTRONICS

51 Stealth Loudspeakers

Quality hi-fi speakers that are virtually invisible.

118 Home Video

 Wireless broadcasting throughout your home.

131 Electronics

 Satellite TV makes a comeback.

DEPARTMENTS

4 Editor's Notes

8 Letters

12 Time Machine

16 Hotlines

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EDITOR'S NOTES

● Even as the world celebrated the end of the Cold War, even as peace broke out between East and West, even as Congress contemplated what to do with the "peace dividend," the president of Iraq, Saddam Hussein, was moving troops into Kuwait. It was one of the most blatant acts of aggression by one sovereign state against another since Hitler's blitzkrieg against Poland in 1939. So much for the peace dividend. Upon hearing the news, I thought back to some of the letters I received after we ran our March cover story on the newest aircraft carriers ("Show Of Force," page 49). Those readers wanted to know why I was running articles on the hardware of war when peace was breaking out all over the world. They discounted the Panama military intervention against Gen. Manuel Noriega as a meaningless brushfire action when judged against the backdrop of world events. It was not a threat to world peace. Well, here we go again. Saddam Hussein is no Noriega, and the Iraqi army is no Panama Defense Force. Hussein has missiles, chemical weapons and a nuclear capability. Whatever the outcome of the events in the Middle East, Hussein's actions have been a sobering reminder that the Third World is studded with madmen hell-bent on controlling the world. We cannot let this happen. We cannot let some third-rate nut job control the destiny and well-being of the United States. Let's learn from history. Let's keep our defenses strong and continue to develop the weapons systems we'll need well into the next century. Not that our present defense posture is weak or that our present weapons systems are not up to present demands. They are, as former Science/Technology Editor Tim Cole found in developing this month's cover story. Even before the present conflict began, we dispatched Cole to the U.S. Navy's Top Gun school in Miramar, California; to fly with the Navy's Blue Angels; and to the USS *Roosevelt* in the Mediterranean. All this to report on America's frontline fighter, the Grumman F-14, the aircraft that puts it on the line every day in the Persian Gulf and wherever U.S. carriers sail. The bottom line? We're ready. Let the Iraqi air force beware. . . . This year's **Woodworking Guide** is the brainchild of Associate Home Improvement Editor Tom Klenck. He proposed that we create a dictionary of woodworking tools that could help the novice—and some experts, too—appreciate the incredible diversity of woodworking tools. The fruits of Tom's considerable labor begin on page 65. And for those of you who thought a gimlet was just a pleasant summertime drink, you might want to check out page 76. Till next time.



Tim Cole



Tom Klenck


Joe Oldham

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Radar Warning Breakthrough

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When we introduced the original ESCORT, its superheterodyne design revolutionized radar detector performance. Now our all-new ESCORT will revolutionize radar warning again.

Its secret? Digital Signal Processing (DSP), an incredible new computer technology.

DSP Technology

DSP is used by NASA to create detailed space photos from blurry images. It's used by military radar to distinguish enemy aircraft. And now we're using DSP to find radar signals too weak to be detected by conventional means.

How it works

The new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This information is digitized and continuously analyzed by a built-in signal recognition computer. The end result is remarkable.

Breakthrough performance

ESCORT's advanced signal processing provides an incredible increase in sensitivity. Quite simply, this means that the new ESCORT picks up radar signals further away than was ever before possible, even distant instant-on radar.



The heart of ESCORT's DSP circuitry is a custom version of the Motorola DSP 56000. This 20 MHz 24 bit parallel HCMOS processor is capable of 10.25 million instructions per second, and is also used in Steve Jobs' new \$10,000 NeXT computer.

"The new Escort packs ultimate sensitivity into a small package. Nothing else even comes close, and no wonder... No analog device can hope to match this performance."

BMW Roundel, December 1989

Intuitive warning system

This additional range would be of little use without a clear, informative warning system. But ESCORT gives you the full report on radar.

Upon radar contact, ESCORT's alert lamp glows and its variable-pulse audio begins a slow warning. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

The moment of truth

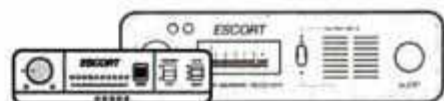
As you get closer, the bar graph lengthens and the audio pulse quickens. You'll understand ESCORT the first time you use it.

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LETTERS

Toyota's Other 4x4

I was upset to see that you left out of your test ("Suburban Chic") one of the oldest and most established 4-door, 4-wheel-drive vehicles—the Toyota Land Cruiser. Although it is not in the same class as the rest of the vehicles tested, you should have at least mentioned that you were comparing everybody else's top of the line with Toyota's number two. From personal experience, I can tell you that a Land Cruiser can go places that no other 4-wheel drive can go. As we like to say, about the only place a Land Cruiser can't go is up a tree.

Even though the 4Runner is one of the best 4-door, 4-wheel drives on the market, it is by no means the best that Toyota can do. The Land Cruiser is Toyota's best.

RYAN TUCKER
CLEVELAND, TN

Young Fan

I think that your magazine is the greatest. Even though I'm only 13, I look forward to the latest issue of PM every month. I especially enjoyed the article "Suburban Chic." I've been waiting for months to see Ford's new Explorer do battle with the other 4-doors in its class, and I'm happy to see that Ford won the comparison.

LEVI BRUBAKER
MODESTO, CA

Not Too Swift

The Swiftfury must have many an old Globe Swift pilot drooling. I enjoyed Fred Mackerodt's flight report, but question the accuracy of his statements regarding the original Swift. During more than 300 hours in a Swift 125, I found it handled beautifully, never "quirky." And in reference to 3-point landings, wheel landings were preferred to permit better



directional control during rollout, but 3-pointers into a short field were easy, and the wing did not "stop flying."

JIM PIPER
LOS ALTOS HILLS, CA

Short Circuit

I found your article on installing low-voltage lighting interesting. I installed a set of low-voltage lights about two years ago and had a problem of short bulb life in the lights. I overcame the problem by installing a half-wave rectifier with adequate voltage and current carrying capacity in one leg of the low-voltage cable at the control box. The rectifier reduces the voltage to the lights and doesn't use any additional power. The bulbs have burned for more than 2000 hours without a failure. This is a cost-effective solution. The rectifier costs about as much as a bulb.

WM. E. BLOCKLEY
BOULDER CITY, NV

Frozen Tubes

In a recent Appliance Clinic question on frozen tubes in a refrigerator's icemaker, Steve Toth explained the cause, but failed to provide a solution.

The cause is impurities in the water supply that collect in or under the inlet valve,

causing the tube to leak and freeze. Install a filter on the supply line to the icemaker, and keep the control valve clean. Change the filter once a year or as necessary. I had the same problem and this solved it.

ARDEN POWELL
FINDLAY, OH

Your idea for the frozen tube is a good one, but may not correct the problem for everyone. The water valve is equipped with a strainer. If local water contains enough impurities, the strainer may periodically become blocked. You will have to remove the strainer and clean it. An additional filter will sometimes help solve the problem if it is impurities in the water. But it would do nothing for the problem if it was caused by something else, such as an air leak.

Due Credit

As a former design engineer and test/program manager on the Crawler-Transporter program, I appreciate your recent article ("A Thousand Miles At 1 Mph") in Tech Update. However, I must also say that in due respect to Don Buchanan and his people at

NASA, the real credit for the program's ultimate success goes to the engineers and workers at Marion Power Shovel Co. It was these people who turned a loose concept into a practical solution.

GUENTER F. LEHMANN
PELZER, SC

School-Built Craft

Seventh and eighth graders enrolled in my design and technology class at Sir John A. Macdonald Middle School in Ontario, Canada, built the POPULAR MECHANICS Pegasus hovercraft over a 2-year period. It was completed as an extracurricular activity before and after school. Test flights were conducted indoors in the shop. We found the 4-hp engine easily lifted 70-kg weights. Progressing outdoors, the air-cushion vehicle gave the builders a real thrill as they mounted their craft and flew around the school yard. We drew random numbers and one of the lucky boys won the hovercraft. Thanks for the interesting project plans.

RICHARD VIDUG
DESIGN AND TECHNOLOGY
INSTRUCTOR
BRAMPTON, ONTARIO



Students at Macdonald Middle School ride the hovercraft they built.

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The light bar on S-10 Baja is not a roll bar.
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Let's get it together... buckle up. *Based on 1999 light-duty truck registration with Chevrolet, the Chevrolet emblem and S-10 are registered trademarks and Chevy is a trademark of the GM Corp. © 1999 GM Corp. All Rights Reserved. See your Chevrolet dealer for terms of this limited warranty.

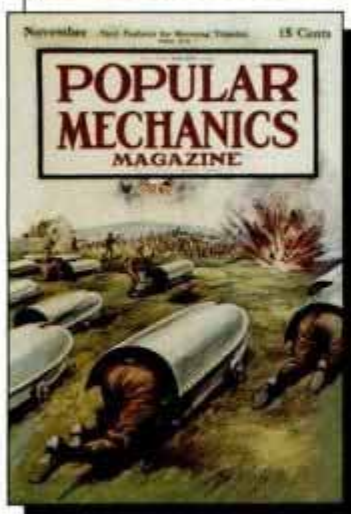


Chevy S-10 Baja 4x4, 4.3L V6. The biggest engine in a compact pickup. It's another reason more truck owners switched to Chevy last year than to any other truck.* Chevy S-10 Baja 4x4. Winning the hearts and minds of bona fide off-road enthusiasts. With more standard horsepower than Ford. More standard torque. Anytime you buckle in, it's a rush.

More People Are Winning With *The Heartbeat*  of America. **TODAY'S TRUCK IS CHEVROLET.™**

TIME MACHINE

75 YEARS AGO: NOVEMBER 1915



Shields On Wheels

Trench warfare and the machine gun had put a bloody end to the classic infantry charge. Military inventors scrambled for ways to break the stalemate on the Western front without unacceptable losses. The British suggested transporting troops inside foot-propelled wheeled body shields. Protected from shrapnel and bullets while they rolled across no-man's land, soldiers would still have to burst from their steel cocoons to storm enemy trenches.

Bluejackets

How different was Navy life in the days of the dreadnought? Our report "Four Years In The Navy" gave a glimpse. Bands played often—at noon, during dinner and to accompany particularly strenuous work, such as coaling the ship. Sailors boxed for sport, often organizing 6-man blindfolded battles royal as shipboard entertainment. Appren-

tice seamen were paid \$250 per year plus keep, while warrant officers, usually 7-year veterans, made between \$1500 and \$2400.



50 YEARS AGO: NOVEMBER 1940



Concept Car

The advent of plastic let industrial designers mold striking prophecies for the automobile. Synthetic materials, they predicted, would provide fade-resistant body color and shatterproof windows that admitted the sun's "healthful" ultraviolet rays, while blocking infrared. Air conditioning would make openable windows unnecessary. Meanwhile, a rear-mounted engine would free up room for enhanced interior space, including curved backseat lounges.

Political Machine

To report the 1940 presidential election, the Associated Press marshalled batteries of telegraphs and automatic tabulators. Race results poured over phone and cable lines from 122,000 precinct correspondents to wire-service offices. There, armies of key-punch operators stacked up color-coded cards until the outcome of the election was un-

questionable. Bulletins then flew out to a populace steadily growing accustomed to instant news delivery.



25 YEARS AGO: NOVEMBER 1965



Commuter Scooter

As suburbs blossomed, they spawned an unforeseen nightmare. Traffic arteries clogged with king-sized family cars driven by solo commuters. So interest grew in ultracompact vehicles for short trips to and from rail stations. We first explored designs for such runabouts from the Illinois Institute of Technology. Then we challenged readers to build a body for a midget IIT-designed 3-wheel chassis, powered by a 150-cc Honda motorcycle engine.

Video's Vanguard

Videotape wouldn't yet dislodge film as the home-movie medium, but the technology was available. Equipment included 70-pound reel-to-reel tape decks, and black-and-white TV cameras requiring AC power. Tape was cheaper than film, but video hardware cost more than the best 16mm film equipment. Rival manufacturers made systems that were, of course, totally incompatible. **PM**





Is it this much?

Maybe this much?

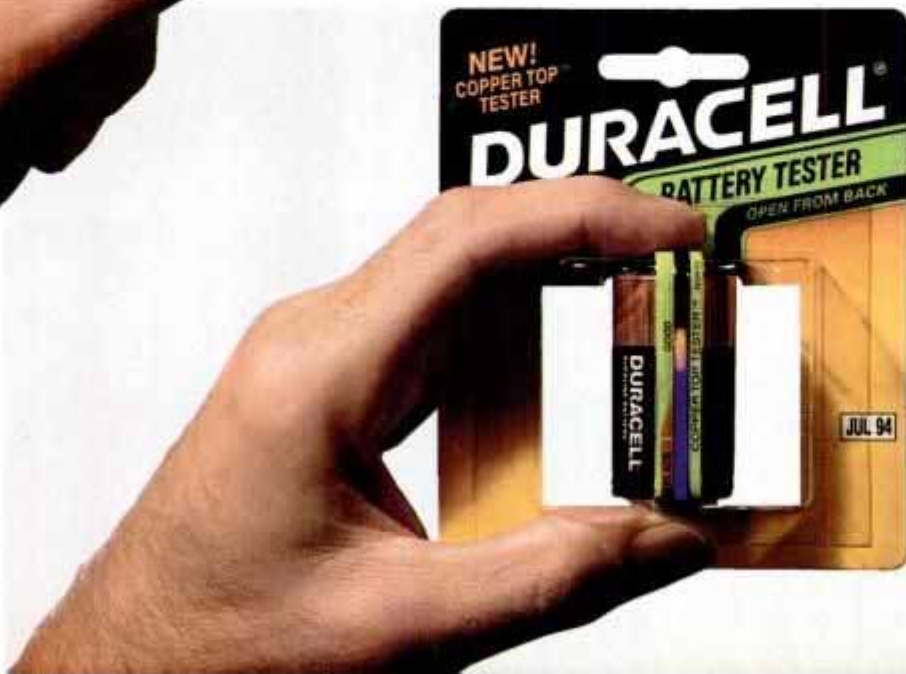
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in a flashlight,
how much power is
left in this battery?**



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little bit?



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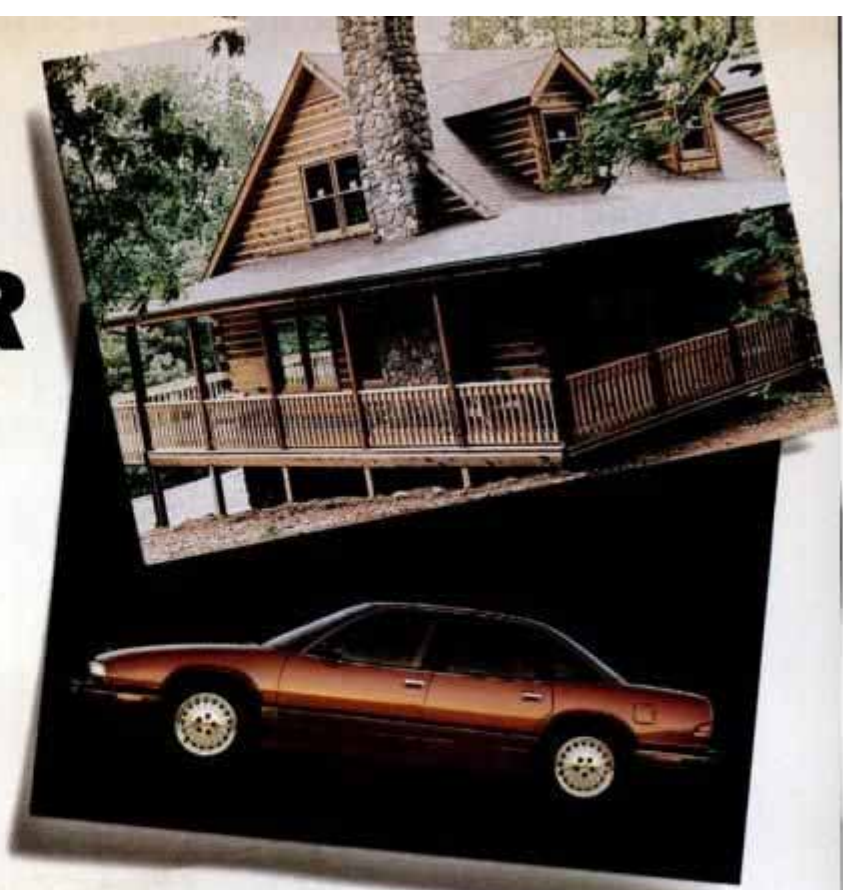
We're looking for must-know men. What's a Must-Know Man? Anyone with a passionate interest in knowing how and why things work. If that sounds like it might be you, simply identify the objects on the facing page, fill out the entry form, and if it's correct, you've already won the Tee Shirt pictured below.

EVERYONE CAN WIN

With the delivery of the Tee Shirt, you'll receive

"The Expert Skills Challenge." Answer twenty-five multiple-choice questions, then send along a photograph or drawing of a project, either conceived by and/or executed by you.

Make sure it's one that you think best expresses the Must-Know Man. If your project is selected, you win one of the five Grand Prizes, or one of a hundred consolation prizes pictured on the right.



THE FIVE GRAND PRIZES

AmerLink Walton Model Log Home weathertight shell package designed for 3 bedrooms, 2½ baths ... kit ready for assembly on your site. (Porch deck, railings, and fireplace not included.) ...valued at \$52,478.

The totally new 1991 Buick Regal Limited Sedan ...valued at over \$17,000.

ProCraft's Procaster 190, designed for the serious water sportsman; powered by a Mariner 150 hp. outboard motor. Prize includes trailer ... valued at \$5,000.

A trip for 4 people to Epcot Center at the Walt Disney World resort. Trip includes RT air fare, 5 days/4 nights at The Grand Floridian and \$1,000 in spending money ... maximum value of \$5,500.

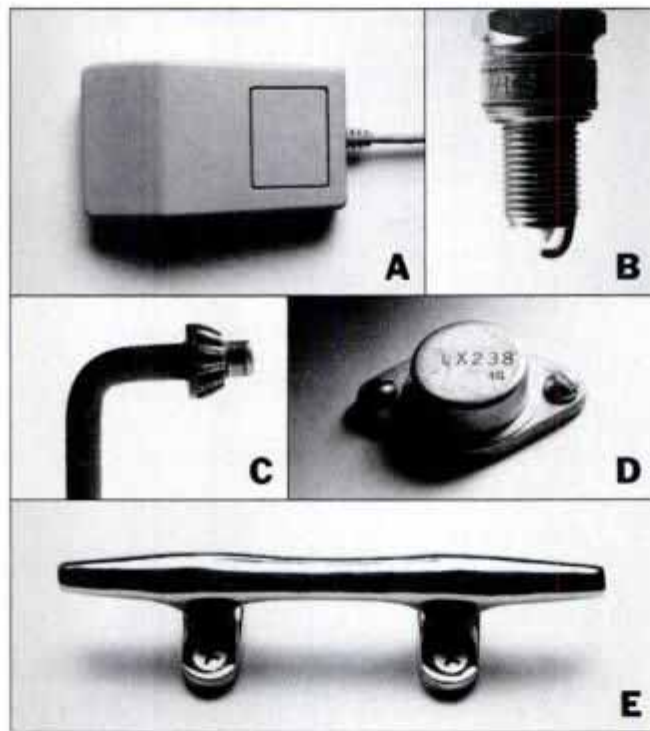
RCA 46" Color Trak 2000 Home Theatre Projection TV ...valued at \$1,755.

100 CONSOLATION PRIZES



Schlage Keepsafer Security System including Emergency Dialer. The Keepsafer is America's best selling, wireless electronic home security system. The Emergency Dialer provides contact with the Schlage National Monitoring Station to provide continuous protection ... each set valued at \$314.

IDENTIFY THESE FIVE OBJECTS CORRECTLY AND YOU'RE ALREADY A WINNER.



CORRECT ENTRIES WIN A TEE SHIRT

The five objects above are each part of one of these five product categories:

1. Automobile;
2. Boat;
3. Stereo Receiver;
4. Power Tool;
- or 5. Computer.

Match the objects A-E with the product name, and complete the Official Entry Form to enter The Search for the Must-Know Man.

All entries must be received by Dec. 31, 1990. If your issue of Popular Mechanics does not have an Official Entry Form, you may obtain one by sending a Self-Addressed Stamped Envelope to: Search Entries, P.O. Box 7324, Kankakee, IL 60902-7324. Requests for Official Entry Forms must be received by Dec. 1, 1990.

OFFICIAL ENTRY FORM

To enter THE SEARCH FOR THE MUST-KNOW MAN, complete this Official Entry Form. No purchase necessary. Only one entry per person. Incorrect entries will not be acknowledged.

Match the 5 objects pictured to the left of this Form with the 5 product categories listed below. Put the correct letter (A-E) inside each corresponding, numbered box (1-5).

1. Automobile
2. Boat
3. Stereo Receiver
4. Power Tool
5. Computer

Please enter me in THE SEARCH FOR THE MUST-KNOW MAN. If my entry is correct, I will receive the MUST-KNOW MAN Tee Shirt and be eligible for the Expert Skills Challenge. I will receive the Challenge Questions and Instructions with my Tee Shirt prize.

See Official Rules on back. All entries must be received by December 31, 1990.

NAME _____
ADDRESS _____
CITY _____
STATE _____ ZIP _____

MAIL TO:
THE SEARCH FOR THE MUSTKNOW MAN
P.O. Box 7325, Kankakee, IL 60902-7325

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OFFICIAL RULES FOR MUST-KNOW MAN SEARCH

1. Take the First Level Must-Know Man CHALLENGE each of the five objects to the left of the Official Entry Form is identified by a letter. Underneath the five objects are questions numbered 1 through 5.
2. The Official Entry Form on the reverse of this page contains boxes numbered 1 through 5. Match the objects to the questions by placing the correct letter inside each of the numbered boxes.
3. No purchase is necessary. Just complete the Official First Level Entry Form to enter the Must-Know Man Search. Be sure to provide your complete name and mailing address in the space provided. Only Official Entry Forms will be accepted. If the Official Entry Form is missing from your issue of Popular Mechanics magazine, you may obtain one by sending a Self-Addressed Stamped Envelope to Search Entries, P.O. Box 7324, Kankakee, IL 60902-7324. Residents of VT and WA may omit postage. Requests for Official Entry Forms must be received by December 1, 1990.
4. Mail this First Level entry to Search for the Must-Know Man, P.O. Box 7325, Kankakee, IL 60902-7325. All First Level entries must be received by December 31, 1990. Sponsor is not responsible for late, lost, delayed, illegible or misdirected mail.
5. You may enter the Must-Know Man Search only once. Duplicate entries will be voided and neither acknowledged nor returned. Judging of First Level entries will be conducted as they are received by Promotional Services Center, an independent judging organization whose decisions are final. Incorrect entries will not be acknowledged or returned. All correct First Level entries win; therefore there are no odds of winning.
6. Within 4 weeks of receipt, all correct First Level entries will receive the Must-Know Man Tee-Shirt. All correct entries will also be eligible to enter the Expert Skills Challenge and will have an opportunity to win one of the 5 Grand Prizes or one of the other 100 Finalist Prizes. The Official Entry Form and rules for the Expert Skills Challenge will be mailed to eligible participants with their Must-Know Man Tee-Shirt.
7. Official Entries in the Expert Skills Challenge must be received by February 28, 1991. The Expert Skills entry form will include mailing instructions. Entrants into the Expert Skills Challenge will be required to answer 25 multiple choice questions or problems posed by the Editors of Popular Mechanics Magazine. Entrants will also be required to submit a photo or drawing of a project of which they are the author and which they believe is most representative of the Must-Know Man. Photos and drawings will not be returned.
8. To be eligible as a finalist or Grand Prize Winner in the Expert Skills Challenge, entrants must have the correct answers to the twenty-five questions. Judging of answers will be conducted by Promotional Services Center. All correct entries which also include the required photo or drawing will be judged by a panel of the 5 Popular Mechanics category Editors, who will make the final selection of the 100 finalists and 5 Grand Prize Winners. The decision of the Editors is final. Finalists will be selected on or about April 15, 1991.
9. Search for the Must-Know Man prizes and their approximate retail value are as follows: 5 Grand Prizes: AmerLink Log Home valued at \$52,478; 1991 Buick Regal, \$17,425*; Procaster 190 boat/motor/trailer, \$15,000; RCA 46" TV, \$1,750. Value of the travel prize to Epicot Center is dependent on point of departure but may not exceed \$5,500. 100 Finalist Prizes: Schlage Keypad & Emergency Dialer valued at \$314 per set. Entry Level Prize: Must-Know Man Tee-shirts, \$8 each. Total value of all prizes is estimated at \$175,000.
10. All prizes will be awarded. Winners will be notified by mail. Prizes are non-transferable and, with the exception of the log home, no substitutions or cash equivalents are allowed. The winner of the log home may elect to receive \$15,000 in place of the log home. Taxes, if any, are the responsibility of the individual winners. Winners will be required to execute an affidavit declaring eligibility, providing release and affirming project authorship, within 21 days after notification, in order to receive prizes.
11. The Search for the Must-Know Man is open to all residents of the United States and Puerto Rico who are 18 years of age or older. Employees and their families of The Hearst Corp., KLO Associates, AmerLink Ltd., General Motors, Inc., Brunswick Marine, American Express Travel, RCA Inc., Schlage Inc., their affiliates, subsidiaries, advertising and promotion agencies are not eligible. Search for the Must-Know Man is void where prohibited or restricted by federal, state or local laws.
12. For a list of major prize winners, send a stamped, self-addressed envelope to Search Winners, P.O. Box 7328, Kankakee, IL 60902-7328. *Retail list price as of July 1990.

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PM HOTLINES

COMMUNICATE WITH US

We're trying our best to make it easier for you to communicate with us. Here are four ways you can do it.

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Special telephone numbers here at Popular Mechanics allow you to call our editors directly and easily. They're activated once a week, on Wednesdays, from 3 to 5 pm Eastern time. All the editorial staff hotline phone numbers are listed here. If an editor is not available, please try again the following week.

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How much electricity

do you need

Electricity, like running water, is one of those conveniences we take for granted. But unlike water, whose flow can be adjusted by turning a tap, the amount of electricity you have available in your house is fixed. It depends on two things: how much electricity you choose to take from the utility company's lines—called the service—and how that electricity is distributed through the house by means of individual circuits. And as everyone knows, when you try to use more electricity than you have, by plugging too many electric appliances into a single outlet, you blow a fuse or a circuit breaker—safety devices that are there for your protection.

Today a standard electric service for an average-size house is 100 amps. (Amps are units of electrical measurements and somewhere on every electric appliance in your house will be printed the number of amps the appliance uses.) Twenty-five years ago it was 60 amps. And it's not uncommon for houses over 50 years old to have only 30 amps of electrical service.

The electricity coming into your house is divided into circuits at the service panel, usually located in the basement or the utility room. In older houses this division happens in the fuse box. There are two types of circuits: Those that supply the 120-volt current used to power lights and small, plug-in appliances and the more powerful circuits that supply 240-volt current to your electric range, dishwasher, clothes dryer and water heater. Usually there is one of these 240-volt circuits for each major appliance you have, and each circuit is rated to handle the number of amps of electricity that the appliance uses when it's on.

The 120-volt circuits are generally all rated for 15 amps. The only exception is in new kitchens, where electric codes now require at least two 20-amp circuits to supply power to the ever-increasing number of small appliances used for cooking. Kitchen circuits cannot supply electricity to any other room in the house.

To determine how many 15-amp circuits you should have in your house, follow this simple formula: Multiply the total square footage of living area in your house by 3, then divide the

result by 1,800. Here's an example of how the formula works: A house with 2,000 square feet of living space would require 3.3 circuits— $3 \times 2,000 \div 1,800$. Since you can't have a third of a circuit, you would need four 15-amp circuits. Putting only three in would lead to a potential overload situation.

This formula is intended to determine the electrical needs for new houses and additions to older houses. But you can use it to see how your present house stacks up against today's standards for electrical service. Older houses can be rewired, and modernizing your electric service should be part of every major remodeling project. Be sure to contact your local electric utility company for more information.



Light up your life

Fluorescent takes on new tasks

When it comes to fluorescent lighting you can forget everything you've learned in the past. All you need to remember is compact fluorescents—the new, super-high-efficiency, miniaturized fluorescent tubes that will probably change the way we light our homes.

It's been known for decades that fluorescent tubes use less energy and last longer than incandescent bulbs. For example, a 20-watt fluorescent tube with a life of several thousand hours has the same light output as a 60-watt incandescent bulb lasting only 750 hours. The problem was that fluorescent tubes were too long to be used throughout the house. Their most common uses were in recessed ceiling fixtures and in under-cabinet lighting in kitchens.

The new compact fluorescent lights, 1/2-inch diameter tubes bent to form a compact U-shaped unit, are only a few inches long. A compact fluorescent 7 (a 7-watt tube with a life of 10,000 hours) is only 3-1/2 inches long but cranks out the same amount of light as a 40-watt incandescent bulb. Two compact fluorescent 9s will replace two 60-watt bulbs. This is not just a theoretical replacement. Compact fluorescent lights come with screw-bases that let them fit many sockets and fixtures in your house. This frequently means they can be used to provide general illumination and task lighting in situations that previously could be handled only with incandescent bulbs. And compact fluorescent lights don't suffer from fluorescent flicker when you turn them on. New ballasts—devices needed to turn on any fluorescent tube—give them an almost instant on.

Compact fluorescent lights are currently available only in cool white and warm white—colors that aren't always the most flattering for applying makeup. So for bathroom applications you might consider using the older style fluorescent tubes, which are available in a variety of colors that render flesh tones more accurately. A lighting dealer who is a member of the American Lighting Association can suggest a combination of fluorescent colors that is right for you.

You
can't work or
play without
light to see.
And today's
technology
sheds more
light on our
lives than
ever before.

Show off your garden or
your whole house with
outdoor lighting—a great
home improvement.



Low voltage means high style

The outdoors is an important part of today's more casual lifestyle. Decks and patios are considered outdoor rooms, and more people are taking pride in their landscaping. But to get full value from our outdoor spaces we need to extend the hours they can be used. That's where outdoor lighting comes in. It's safe, inexpensive, improves the security on your property and, in the words of Rhode Island lighting consultant Neil Mitchell, lets you continue to entertain on your deck after the big light in the sky has gone out.

One type of outdoor lighting operates on a low-voltage system. That is, it takes normal 110-volt house power and converts it, by means of a transformer, to 12 volts that power the individual lights. The wire used in this system is thin and flexible and doesn't have to be buried. If it's accidentally cut by a garden tool or your cat bites through it, you or your cat won't get a serious shock. Both the wire and light fixtures are impervious to weather—even snow and ice—so there is no maintenance after you put the system in. And low-voltage bulbs last for years.

There are a wide variety of light fixtures to choose from depending on whether you want to provide accent lighting for you landscaping, safety illumination for steps, walks and driveways, or general illumination for a deck or patio. The system can be controlled by a switch, or you can use the photocell that's built into many transformers to turn the lights on at sunset. As a security measure, low-voltage spotlights can be equipped with motion detectors set to trigger the light in the event of a prowler—yet they won't pick up the movement of a passing animal.

Installing low-voltage outdoor lighting is an easy do-it-yourself project. A basic kit containing a transformer and half a dozen lights can cost under \$50, and no special tools are needed. However, if you want something more extensive, Mitchell suggests that you talk with a landscape-lighting professional. Many lighting showrooms have trained personnel on staff who can design a system based on your current need using the components of your choosing, which can be installed according to your budget and added to as your needs change.



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Have it all with heat

The key to year-round comfort lies right

Imagine an inexhaustible source of heat. A source that's always there, that you don't burn in a furnace. Now imagine this same source of heat reversing itself to provide the cooling you need in the summer. Impossible, you say. Not at all. You're standing on it—it's the ground under your feet.

Using that ground as a provider of comfortable and controllable indoor temperature is what Ground Source Heat Pumps (GSHPs) are all about. This is possible because the earth maintains a more or less constant temperature of 50° F. Even in winter, when the ground is frozen, the earth below the frost line will maintain a 50° temperature. This fact, combined with one or two basic laws of physics, means you can count on that 50° ground as a source of heat even on the coldest winter day.

Get heat from the ground

It's been known for a long time that GSHPs are more effective than air-source heat pumps. Air-source units, as the name implies, extract heat from the outdoor air. As the air temperature drops below 30° F, a supplemental electric backup heat source is required to maintain indoor air comfort.

A GSHP, on the other hand, becomes a completely self-contained heating system that can be used at all times in any part of the country by taking heat from the earth instead of the air. No supplemental heat source is needed to see you through the cold months.

To get the ground's heat into your house, the GSHP system uses a closed loop of indestructible piping buried in your backyard. The loop is filled with a mixture of water and antifreeze that is kept circulating by a pump. So freezing isn't a problem.

The ground also cools off far more slowly than the air. "In fact," says Jeffrey C. Anderson, secretary/treasurer of the Northland Heat Pump Association and director of marketing for a Minnesota power cooperative, "when you're talking about underground loops, you're talking about the effects of a seasonal temperature variation that's two months

Today's
electric heat
pumps are
more efficient
than ever.
From air-
source to
ground-
source, heat
pumps can
save energy—
and that's
good for the
environment.



behind what's happening above ground. This means that for your heat pump system it doesn't get to be January below ground until it's March above ground. And when March finally rolls around on the calendar, the heating season is almost over."

Just like your refrigerator

Simply explained, a GSHP works like this: The water circulating through the closed loop is colder than the surrounding earth, so the earth, following the laws of physics, transfers its heat to the water. When the water in the loop reaches the compressor, it transfers the heat it gained from the ground to a refrigerant, and a refrigeration cycle begins. It's the same principle that makes your kitchen refrigerator work. In fact, refrigerators are air-source, rather than ground source, heat pumps. This isn't as confusing as it sounds. Stand near your refrigerator when its compressor is running and you will feel warm air blowing out from a grill near the floor. The GSHP creates the same warm air, and this is what heats your house.

Warm air from the heat pump is usually circulated around the house through ductwork by means of a blower. However, it is also possible to transfer the heat from the refrigeration cycle to water that feeds modern, baseboard hot-water radiator units. Use this heat to run a hot-water boiler system that feeds modern, baseboard radiator units.

Heat pumps are cool too

In the summer, you can reverse the way your heat pump operates and use it for cooling. When you do this, the inside of your house becomes like the food inside your refrigerator: It cools off. The heat pump draws the heat out of the rooms—leaving them cool—and the warm air this generates (the same as the warm air you feel blowing out from your refrigerator) is transferred back through the refrigeration cycle to the water in the closed loop. Because the outgoing water in the loop is now warmer than the earth around it, the heat transfer also works in reverse: The earth absorbs the heat

pumps

in your backyard

from the water and becomes a heat sink, disposing of the heat from your house. You can also divert some of this heat to supply most of your domestic hot water during the summer. It's a completely free byproduct of the system during the cooling operation.

Better efficiency means savings

So much for the mechanics of GSHPs. What do they mean for your heating budgets? All heating systems have an efficiency rating—a gauge that tells you how much heat comes out for a given amount of fuel that goes in. For example, an average fossil-fuel-burning furnace has an efficiency rating around 65%. That means 65% of the fuel turns into heat, while 35% goes up the chimney and is wasted. So-called high-efficiency fossil-fuel furnaces have efficiency ratings as high as 96%. By comparison, a GSHP can have an efficiency rating of between 300% and 400%. And according to Anderson, right around the corner are units with efficiency ratings of 500% or better. Depending on local electric rates and fuel prices, these high-efficiency ratings mean that the annual operating costs in some installations could be one-half of what they would be if a fossil-fuel furnace and a standard air conditioner were used.

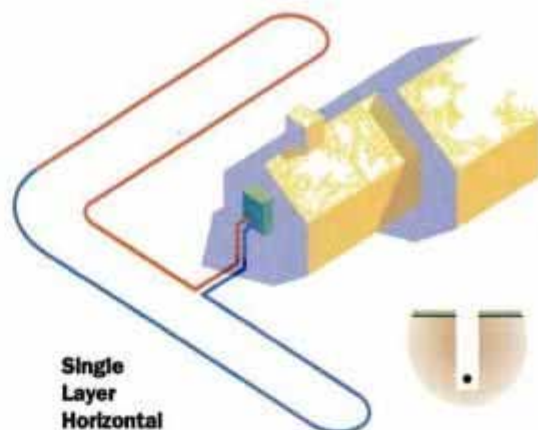
These savings make the installation of a GSHP system an attractive option for those people who want to upgrade their heating systems and particularly for those who want systems with hedges against any future energy crisis. The installation cost for a GSHP runs between \$5,500 and \$8,500—depending on size. Air-source units cost about half that. The difference is the cost of excavating and burying the closed loop.

While this is initially more than you would pay for a fossil-fuel system and an air conditioner, the longer view of the purchase shows substantial down-the-road savings. For example, let's say a GSHP costs \$2,400 more than a fossil-fuel furnace/air conditioner to install but saves \$400 per year in energy costs. The payback of the purchase and installation cost would occur in six years. From that point on, the yearly savings in energy costs would have a

Ground Source Heat Pumps

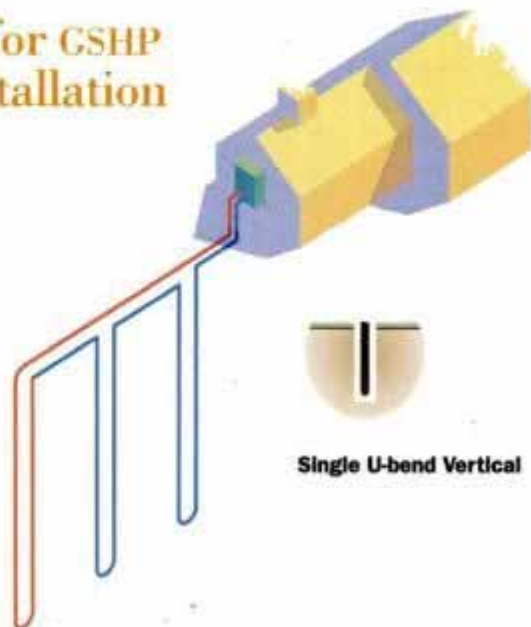
very positive impact on your household budget. For new home builders, the additional monthly payment on the mortgage can be more than offset by the monthly reduction in energy costs.

Heat-pump buyers may also qualify for installation incentives offered by their local utility. Additionally, and now speaking as director of marketing for a local power company, Anderson notes that many utility companies offer customers off-peak power-management programs that can cut the price per kilowatt of electric power by half or more. As to the cost of installation, says Anderson, "I like to say that the loop in your backyard is not a cost but an investment in your own oil well." That's something to think about....



Two options for GSHP backyard installation

Where you live will determine how deep you have to bury your ground loop, and the size of your lot affects what type of loop system you should choose. If you have a large backyard, you can run the loop horizontally around your house. But for smaller yards, you can dig deeper and run a vertical loop system. Your local utility company can tell you the exact size of the loop you need.



The can-do electric kitchen

A world-class chef predicts trends for the

No room has changed more over the last quarter century than the kitchen. In the middle 1960s, it was a room barely adequate for food preparation. Only the most modern kitchens had dishwashers, trash compactors hadn't been invented, and many of the small convenience appliances we now take for granted were still on the drawing board. It's all different today. And electricity is what has powered the kitchen to its position of prominence and turned it into the most important room in the house.

Nobody doubts that toasters, coffee makers, mixers, microwaves, blenders, food processors and the like could run on anything but electricity. The notion that it makes the best heat source for cooking and baking is something that's hotly debated by many chefs. So it may come as a surprise to weekend cooks and professional chefs alike that the 1992 Culinary Team USA plays all of its events on the burner elements of electric ranges.

With 20 years of food service experience at Disney World, in Orlando, Florida, Chef Keith Keough is the manager of Team USA. He also has some pretty good ideas of what's ahead for the American kitchen of the 1990s. The biggest advance, he says, is in halogen and infrared elements, which give electric ranges and cooktops the capability of instant heat. "And with these elements you also have the ability to make small, important adjustments to the heat—vital when preparing certain sauces. The days of being able to punch only No.2 or No.3 on your coil burner, with no heat setting in between, are gone," he adds.

Keough also expects to see more convection ovens in the kitchens of the 1990s. As countertop appliances, these ovens have enjoyed only limited popularity, but the new generation of convection ovens will probably

90s

Quick

and easy.

That's what

your next

kitchen will be

as electricity

puts back

the joy of

cooking.

be built-ins and have some important new features, such as also functioning as steamers. In addition to the fact that steaming is one of the healthiest ways to prepare food, Keough points out that the ability of these new convection ovens to inject water into the cooking process will mean less shrinkage when the oven is used for something as conventional as a Christmas roast.



1990s cooktops feature controllable halogen elements.

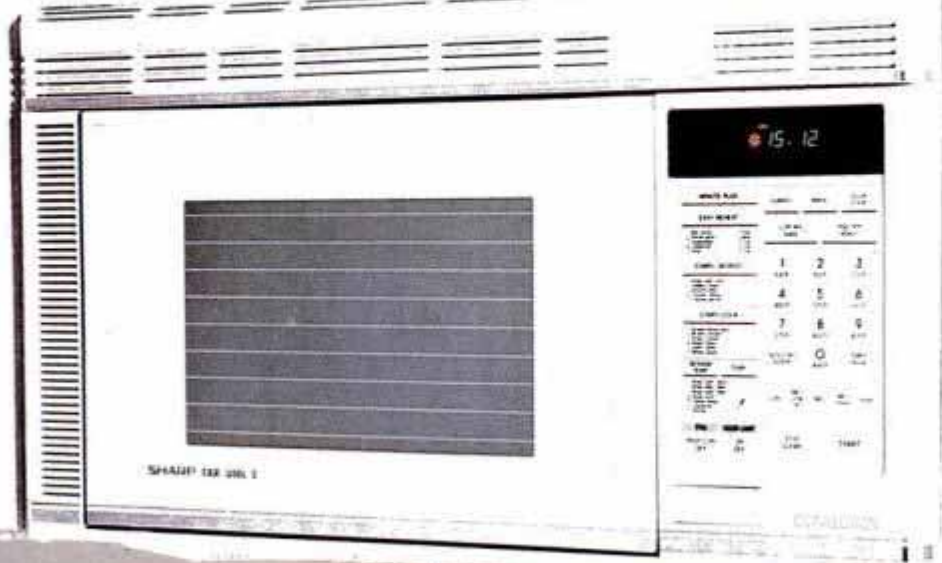
Microwaves will continue to be the centerpiece in most kitchens—a fact that should surprise no one. But there is a surprise when it comes to what we are going to be putting into them. Until now, and in spite of all those microwave cookbooks you can buy, most of us use them primarily for heating up already-cooked meals. This is about to change. A new European technology, called by its French name *Sous-Vide* (literally, under vacuum), offers nonfrozen, raw vacuum-packed meals that are designed to be cooked from scratch in the microwave. Keough reports that *Sous-Vide* packaged meals are big in Europe, and he expects them to be popular here too. "With the

Sous-Vide meals, the microwave is going to play a bigger role in day-to-day cooking activities," Keough says. "Though many people still want family-type cooked meals on weekends and hobby-cooking continues to flourish, convenience is going to be the most important factor in preparing weekday meals."



Ready to take a fourth straight gold medal in the Culinary Competitions, Team USA looks forward to two more years of grilling practice before the final competition in 1992.

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Keep Things Safe

While we may take the convenience of modern electric appliances for granted, using them safely is something we should always be thinking about. If you follow a few basic rules—common sense really—you'll always be sure to get the maximum benefit from appliances that save our time and make life more enjoyable.

Electricity and water don't mix. The professionals who write the National Electric Code know this, so there are special safety requirements for outlets located near a source of water—such as a sink—or for outlets installed outside the house. In these situations you must install what's called a Ground Fault Circuit Interrupter (GFCI), which is nothing more than an outlet with a built-in circuit breaker that is very sensitive to changes in the flow of electrical current. The purpose of the GFCI is to prevent dangerous shocks, something that can readily happen when a person who is wet comes in contact with an electrical source. The GFCI senses the start of a shock and trips off its internal breaker, shutting off the current, before the shock becomes harmful.

GFCIs have been required in bathrooms for many years: The outlet used for the hairdryer and the electric shaver is a GFCI. But they have only recently been required near kitchen sinks. So the likelihood is that, unless you have recently remodeled your kitchen or bought a brand new house, you don't have a GFCI there. Installing one is a good idea. GFCI outlets cost about \$25, and if you've worked with electricity before, you can install it yourself. Otherwise, have an electrician do it for you. It's money well spent.

Here

is a common-

sense check-

list for using

your electrical

appliances

safely and

efficiently.

Here are some other common-sense safety tips to keep in mind:

- Read the directions before using any electrical appliance or power tool; then follow them.
- Never use any electrical device outdoors when it's raining.
- If an appliance or a lamp doesn't work, unplug it before you look for the trouble.
- If a switch doesn't work, or there's no power coming from an outlet, throw the appropriate circuit breaker to the off position before you remove the cover plate to investigate.
- Make sure every circuit breaker (or fuse) is identified. And never replace a blown fuse with one rated for a higher amp output.
- Standard electrical outlets are designed for either two or four plugs. Don't add octopus adapters to accommodate more.
- If you must use an extension cord, choose one long enough for the job. Don't plug one extension cord into another to make the reach. And never run an extension cord under a rug.
- Never exceed the recommended maximum bulb wattage in any light fixture or lamp.
- When using an extension ladder outdoors, be on the lookout for overhead electrical wires.
- European-style, cast-iron, disk-type cooking elements may take longer to cool down than coil-type elements, so they can cause a burn after you have finished cooking.
- When unplugging an appliance, always pull from the plug and not from the cord. Constant tugging on the cord can cause it to pull away from the plug, possibly exposing a live wire.

For more information

Your electric utility can provide you with information that can be useful if you are planning to up-grade your heating and cooling system, remodel your kitchen or make any home improvement that involves adding either electricity or electrical appliances. Or contact these associations:

The International Ground Source Heat Pump Association, 101 Industrial Building, Oklahoma State University, Stillwater, OK 74078.

The National Kitchen & Bath Association, 124 Main Street, Hackettstown, NJ 07840. Ask for their pamphlet *You and Your Kitchen*. The cost is \$3.

The American Lighting Association, Department H, 435 N. Michigan Ave., Chicago, IL 60611. Ask for their pamphlets, *Lighting Your Life* and *Light Up Your Landscape*, \$2 each.

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WRITTEN BY: JOHN DRIEMEN
DESIGN: 2 AND 3 D

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PUT LESS ENERGY INTO KEEPING YOUR FAMILY COMFORTABLE.



When it comes to keeping your home a comfortable temperature, an electric heat pump is a more efficient way to get the job done.

For starters, you get year-round comfort from a single piece of equipment — one that is 3 to 4 times more efficient than a gas unit. The newest high-efficiency electric heat pumps can even help cut hot water costs because they heat water as well as the house. And because a heat pump uses less energy, it's the right choice for a cleaner environment.

A high-efficiency heat pump can also cut building costs because there's no need for extra piping for gas or oil. And no need for a chimney or flue. So you can build a tighter, better insulated house. Which means less heat loss and a more consistent temperature overall.

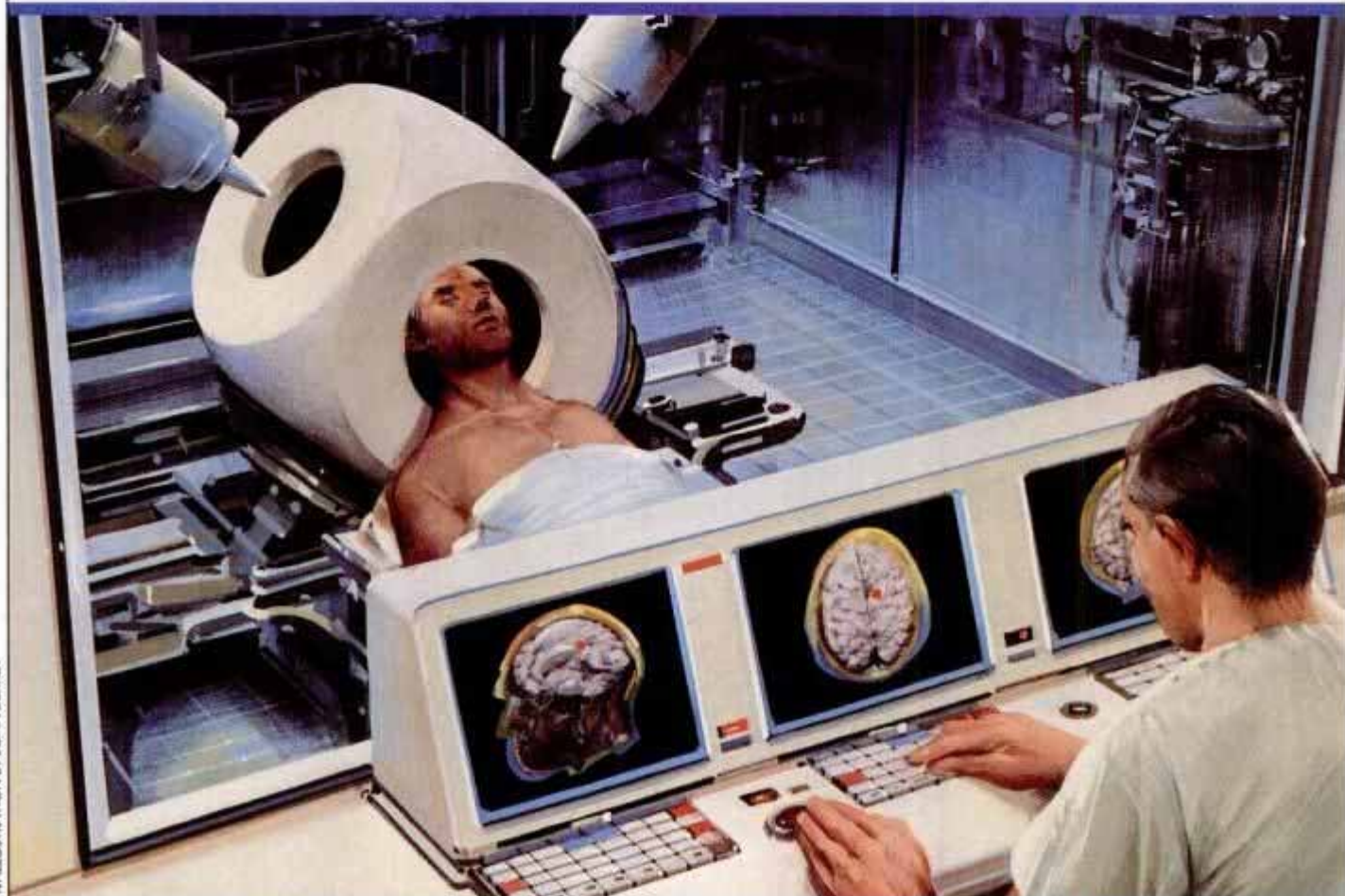
To find out more about energy-efficient heat pumps, call your electric utility. We've got news that'll make your family feel warm all over.



Electricity.  A better world is in your power.

TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY JOHN BERKEY

Video Tumor Fighter Close To Human Trial

CHARLOTTESVILLE, VA—The neurosurgeon of the near future wields a joystick as well as a scalpel. Sitting before a bank of video monitors, he guides a magnetic BB-sized pellet through the brain into a deep-seated tumor. Then he heats the pellet with radiowaves and moves it back and forth to wipe out the growth.

The hardware behind this procedure is actually not far off. Researchers at the universities of Virginia and Washington have tested a Video Tumor Fighter, or VTF, on lab animals, and a prototype system for human trials is near completion.

Six superconducting magnetic coils will surround the

patient's head. After the magnetic pellet has been surgically introduced, the surgeon uses his joystick to control the current to each of the magnets, which pull the pellet around the brain. Animal experiments show that the pellet pushes harmlessly through brain material.

To navigate, the surgeon views X-ray images (which pinpoint the pellet) superimposed on magnetic-resonance images (which show anatomical detail).

The VTF promises more thorough surgery and less damage to healthy tissue than conventional treat-

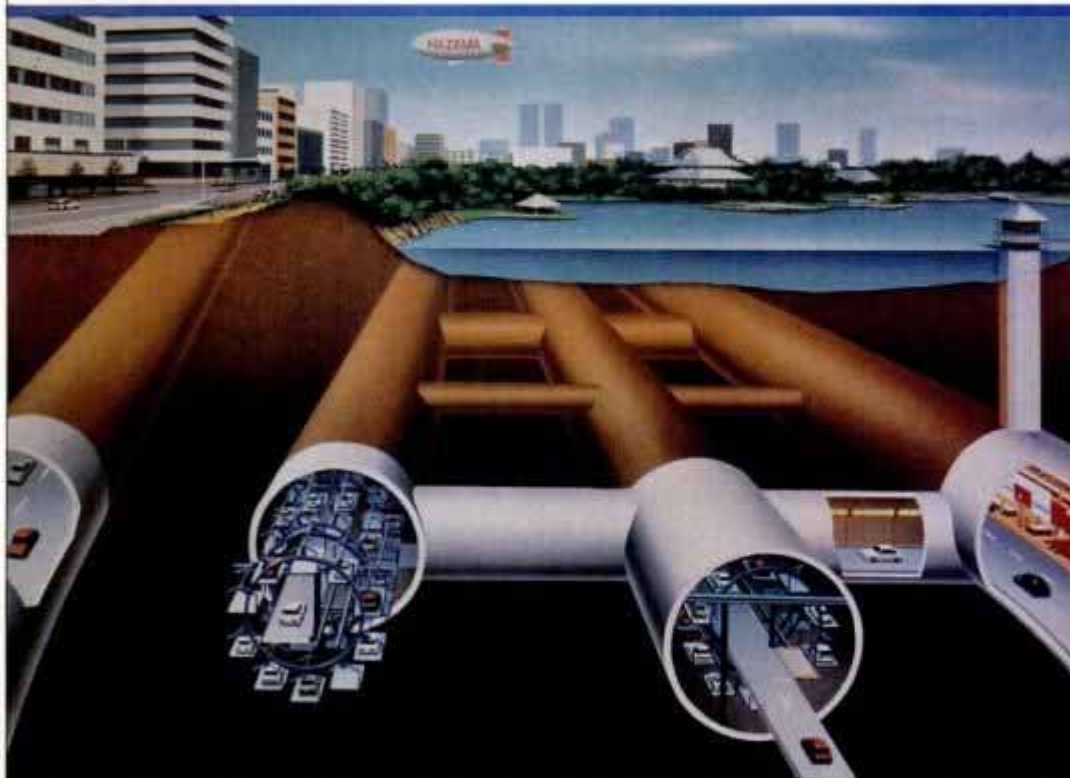
ments. Researchers hope to begin human trials as soon as approval is given, possibly by the end of this year.

VTF neurosurgeon guides pellet toward tumor. Once at target, pellet absorbs RF waves, heats up, and destroys malignancy.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Bob Scheier, Mike Fillori

Highlights This Month

- **Racing With The Sun**—Solar speedsters gear up for outback marathon.
- **Attack Of The Avenger**—Navy previews the new A-12 strike plane.
- **Breakthrough Ice**—Superdiamonds are better than the real thing.
- **Decisions On The Fly**—Smartest airborne command post ever.
- **Drilling With A Twist**—Japanese tunnelmakers turn the corner.
- **How They Build The B-2**—It takes ultrasonic knives and 75,000-rpm machine tools.



HAZAMA ILLUSTRATION

Revolver Parking Lot

TOKYO, JAPAN—Japanese civil engineers must squeeze as much value as they can out of their congested urban space, even underground. One innovation, which has been proposed by Hazama Corporation, is a subterranean parking garage featuring revolving rings of car-holding pallets.

Drivers would pull onto a movable, rail-mounted platform alongside the tunnel road. Platform load sensors trigger the rotation of one of five rings until a free pallet lines up with the platform. The platform then slides to the ring and the car is loaded automatically.

Hazama is awaiting government approval to build the first unit next year.

Revolver parking tunnel consists of 10-pallet rings rotated and filled automatically.

Solar Racers Brace For World Challenge

DARWIN, AUSTRALIA—Several U.S. entries will face off against global competition in this month's World Solar Challenge.

Three of the American cars are those that won, placed and showed in last July's GM Sunrayce USA, which pitted 32 university-built solar racers against each other.

The University of Michigan's wheeled catamaran *Sunrunner* took first place after covering the 1640-mile course in 72 hours, 50 minutes and 47 seconds, at an average clip of 22.5 mph. The Michigan team took advantage of a weather-forecasting forward scout vehicle and a computerized map of traffic lights and speed zones.

Two hours behind *Sunrunner* came the University of Maryland's *Pride Of Maryland*, modeled after GM's own 1987 World Challenge winner *Sunracer*. Third place went to Western Washington University's bidirectional *Viking XX*, which featured a slanted solar panel



and a steering assembly on each end, allowing drivers to turn around and take advantage of either morning or afternoon sunlight.

The trans-Australia World Challenge should see higher average speeds than Sunrayce USA, due to flatter terrain and a higher sunlight level.



Michigan's *Sunrunner* (top) won U.S. race. Rivals included (clockwise, from above left) Cal State's *Solar Eagle*, Western Washington's *Viking XX*, Florida Tech's *Sunshine Special* and Crowder College's *Star II*.



AP/WIDEWORLD PHOTOS

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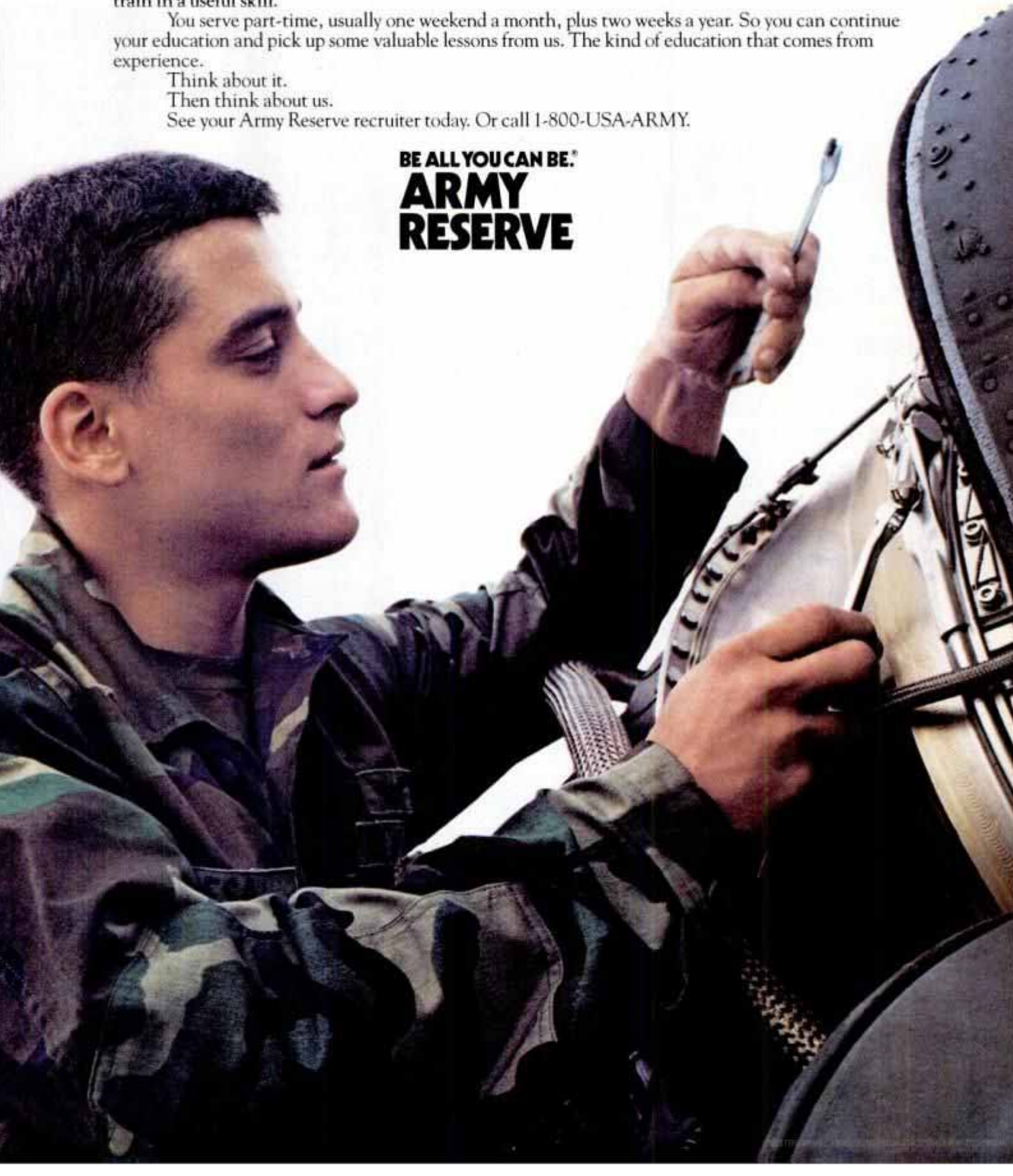
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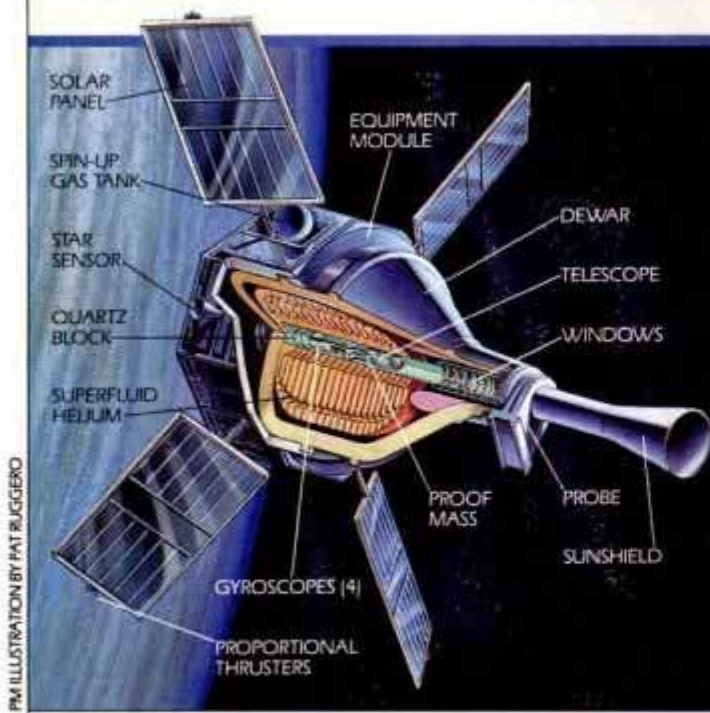
STANFORD, CA—Whether Einstein was right about gravity will finally be tested 400 miles above the Earth.

Stanford University and NASA are building Gravity Probe B, a satellite housing four near-perfect gyroscopes. They will check two predictions made by Einstein's theory of general relativity, which states that the gravity of a massive object warps space-time.

If Einstein's right, then a rotating massive object, like **Shielded by liquid helium and lead, the probe's gyros will point to the star Rigel. Drift indicates gravity's relativistic effects.**

Earth, should actually drag space-time along with it. A spinning gyroscope, circling Earth in polar orbit, will be tilted by this dragging. A similar tilt should also be induced by the gyro's moving through warped space-time.

Because these changes are minute, they can be detected only under near-ideal conditions. The gyroscopes are electrically levitated balls of niobium-coated quartz so close to perfect spheres that if they were the size of Earth, the biggest imperfection would be only 8 ft. high. A Titan II rocket will put the probe into a polar orbit in 1996.



PM ILLUSTRATION BY PAT RUGGERO

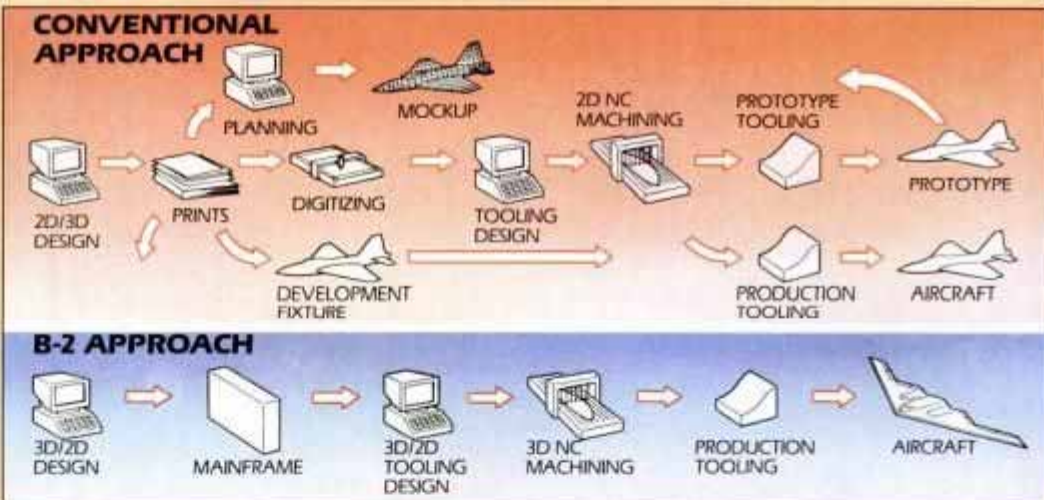
Stealth Manufacturing: Building The B-2

PALMDALE, CA—No matter how few B-2s ultimately roll out of Northrop's assembly plant, the bomber's development will have had a major impact on aircraft manufacturing. Unprecedented secrecy and use of composite materials forced a rethinking of plane design and manufacturing processes.

Because no prototype was ever built, the first B-2 was assembled on production tooling machined directly from a 3-D computer-aided design and manufacturing (CAD/CAM) database. Ordinarily, aircraft tooling goes through several generations of foam and wood versions before master tools are cut.

In addition, contractors developed new machinery to handle the B-2's composite-material skeleton and complex geometry. Driven by the tooling software, a 5-axis tape layer quickens the fabrication of composite rib stiffeners by up to 60-fold, says Northrop. And a high-precision ultrasonic cutter knives through the stiff material three times faster than conventional methods.

Suppliers are already introducing these and other technologies into commercial aircraft manufacturing.



B-2 manufacturing (above) leapfrogs conventional tooling steps. Computer-controlled tape layer (below right) and 75,000-rpm milling machine (bottom right) speed flow of parts to assembly floor (below left).



PM ILLUSTRATION BY HANK KEN

NORTHROP PHOTOS

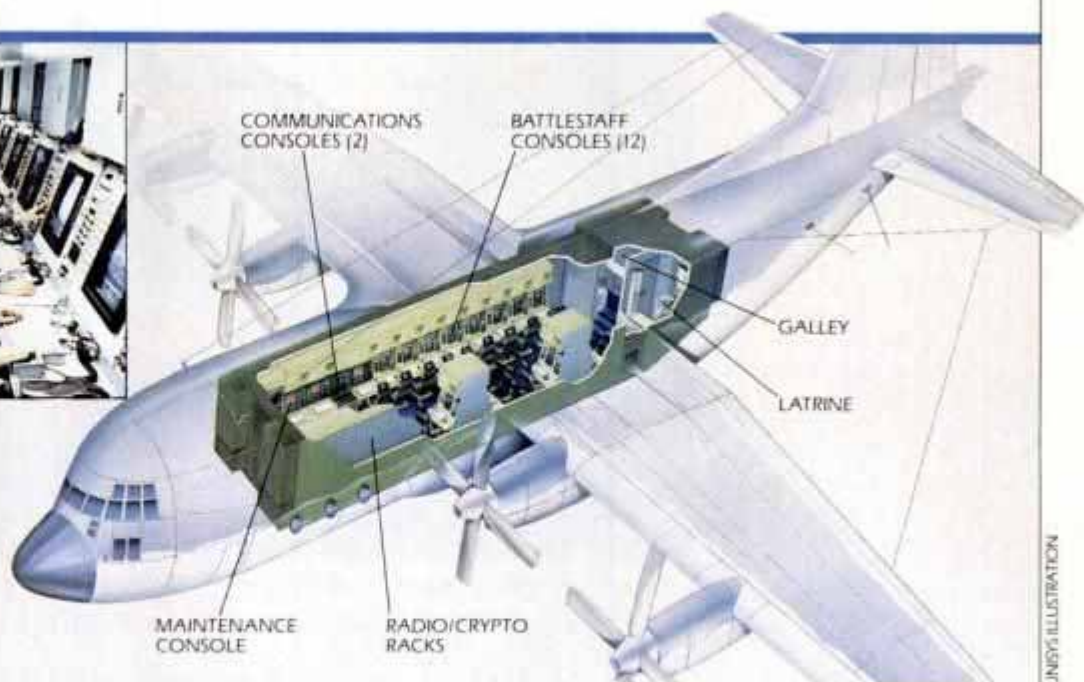


New Flying War Room

KEESLER AFB, MI—The U.S. Air Force's third-generation tactical Airborne Command and Control Center (ABCCC) is now operational.

The 47-ft.-long module, which slides aboard an EC-130E, packs electronics to replace the paper maps and grease pencils of previous versions used in Vietnam and Grenada.

Resistant to electromag-

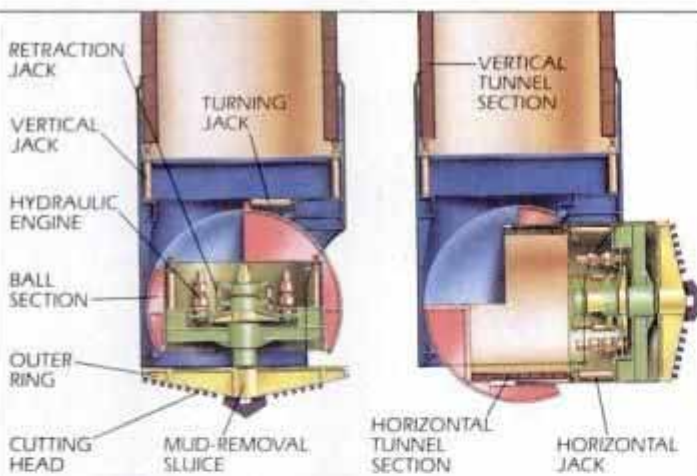


Highly automated airborne command post features 15 consoles for 7th ACCS personnel (above left).

netic interference, optical disks store data, including detailed maps that can zoom in from 4000- to 16-sq.-miles coverage in less than 2 sec-

onds. Meanwhile, automated digital switching relays information and orders between ground headquarters and combat forces.

As of this writing, the 7th Airborne Command and Control Squadron is to have received the first two of eight ABCCC units by September.



Three sets of jacks push down cutting head vertically to turning point, rotate cutting head assembly and push it horizontally.

Drilling Corners

TOKYO, JAPAN—Three Japanese companies have put a new twist on tunnel drilling machines. They've developed a cutting head that can rotate 90° after boring vertically into the ground.

The turnable cutting head is part of a continuous-shield driller—meaning that, as it burrows, it leaves a tunnel that is then lined with concrete or steel.

When the cutting head reaches the bottom of the vertical tunnel, its outer ring separates and drops off, reducing the cutter's diameter. That makes it possible to turn within the existing vertical shield. The cutter first retracts into the shield, then its spherical housing turns to face horizontally.

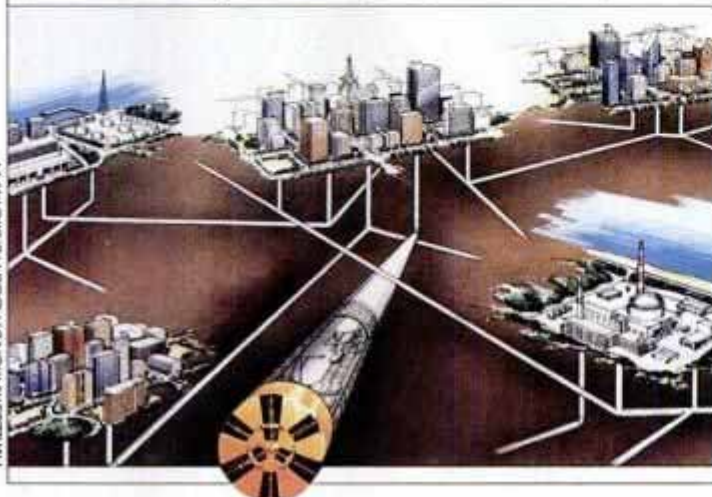
The conventional alternative has been to bore a double-width vertical shaft to allow assembly of a second driller at the bottom. Engineers plan to test the first unit next year and say a smaller vertical shaft saves 30 percent of dig costs.



Pyrotechnic reaction cooks at 4000° F to forge exotic materials.

Firework Metallurgy

ATLANTA, GA—A cheaper process for making heat-resistant aerospace materials draws on an old fireworks principle—burn magnesium with metal oxides, and a self-propagating pyrotechnic reaction takes off. With the right ingredients, the reaction's residue is a lightweight foam flecked evenly with titanium diboride. Georgia Tech is commercializing the process.

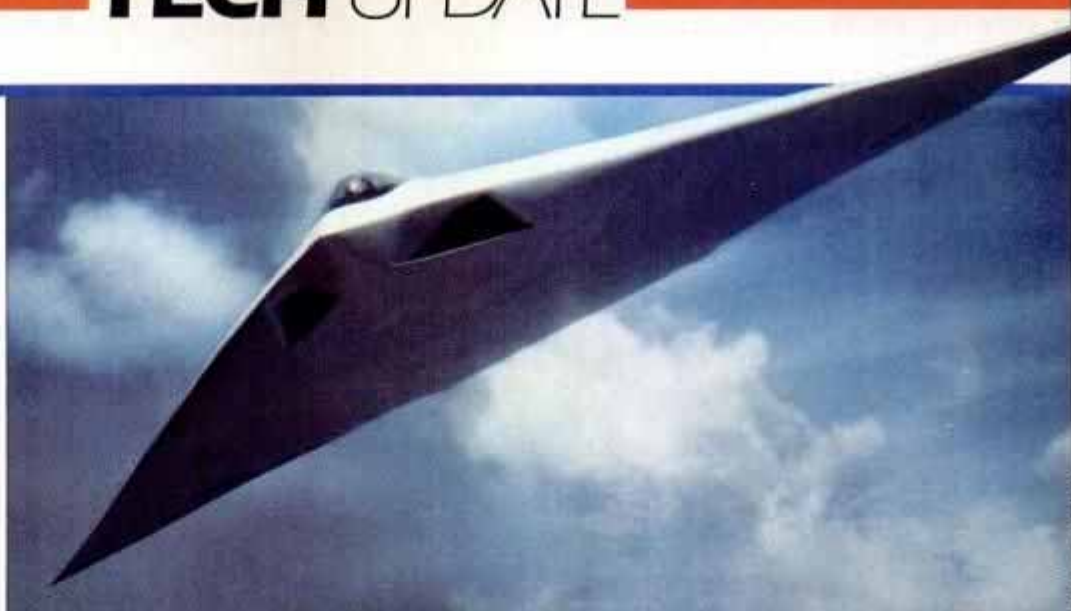


Stealthy Avenger

WASHINGTON, D.C.—The A-12 Avenger, follow-on to the Navy's A-6E Intruder attack plane, will bear a striking resemblance to the Air Force's B-2 bomber, according to a recently released artist's rendition.

Longer in range and faster than the A-6E, the A-12 will load up internal weapons bays and carry out all-weather strikes from carriers. In addition, the planes could take on jamming and anti-submarine warfare roles, as well as air-superiority missions, if armed with long-range air-to-air missiles.

In the cockpit, pilot and bombardier will benefit from



NAVY ILLUSTRATION

Navy shows tandem cockpit but offers no clues on rudders, trailing edge or wing-folding mechanism.

the first aircraft use of both fiberoptic data transmission and long-awaited military-spec Very High-Speed In-

tegrated Circuit (VHSIC) microchips.

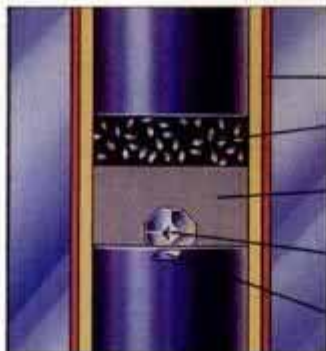
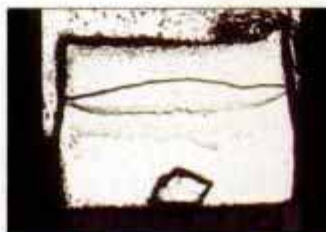
General Dynamics and McDonnell Douglas are current-

ly building six of eight Avengers for operational testing and evaluation. First flight is scheduled for 1991.



GE PHOTOS, PM ILLUSTRATION BY HANK KEN

GE researchers used a superpress (above right) to force dissolved diamond powder onto seed.



The Ultimate Diamond

SCHENECTADY, NY—Not only are diamonds the hardest things on Earth, they're also the best at conducting heat. Now General Electric chemical engineers have forged superdiamonds that outperform their natural counterparts.

The new gems conduct heat 50 percent better, and are so transparent that they absorb 10 times more laser energy without degenerating into graphite.

These proper-

ties stem from isotopic purity. GE's gems are 99.9-percent carbon-12.

GE scientists first stripped carbon atoms from all-carbon-12 methane and deposited them as a thin diamond film. After pulverizing the film, researchers dissolved the powder in a metal catalyst at tremendous pressure and temperature. The carbon recrystallized on a tiny seed diamond to grow into a carat-sized gem.

The diamonds could be used as heat dissipators on microchips or optical components for megawatt lasers.


Tank Antenna Tester

FORT HUACHUCA, AZ—The Army has a powerful new tool to determine how a vehicle's geometry affects the performance of its communications antenna.

Georgia Tech designed and built an outdoor compact antenna range, believed to be the world's largest, for the Army's Electronic Proving Ground. The range consists of a 75-ft.-dia. parabolic reflector and a hydraulic positioner capable of gripping and rotating 70-ton tanks 42 ft. off the ground.

A feedhorn at the base of

the positioner bounces signals off the reflector back toward the target. Serrations at the reflector's edge enlarge the "quiet zone" (the circle of clear electromagnetic radiation projected by the reflector), enabling entire vehicles to be tested.

The Army plans to use the range to test communications at frequencies up to 100 GHz and to examine radar cross sections of armored vehicles and aircraft. 

Huge parabolic reflector bathes tank in radiowaves to check vehicle's antenna performance.



GEORGIA TECH PHOTO

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Astro Lite power will protect you with fast, reliable starts.

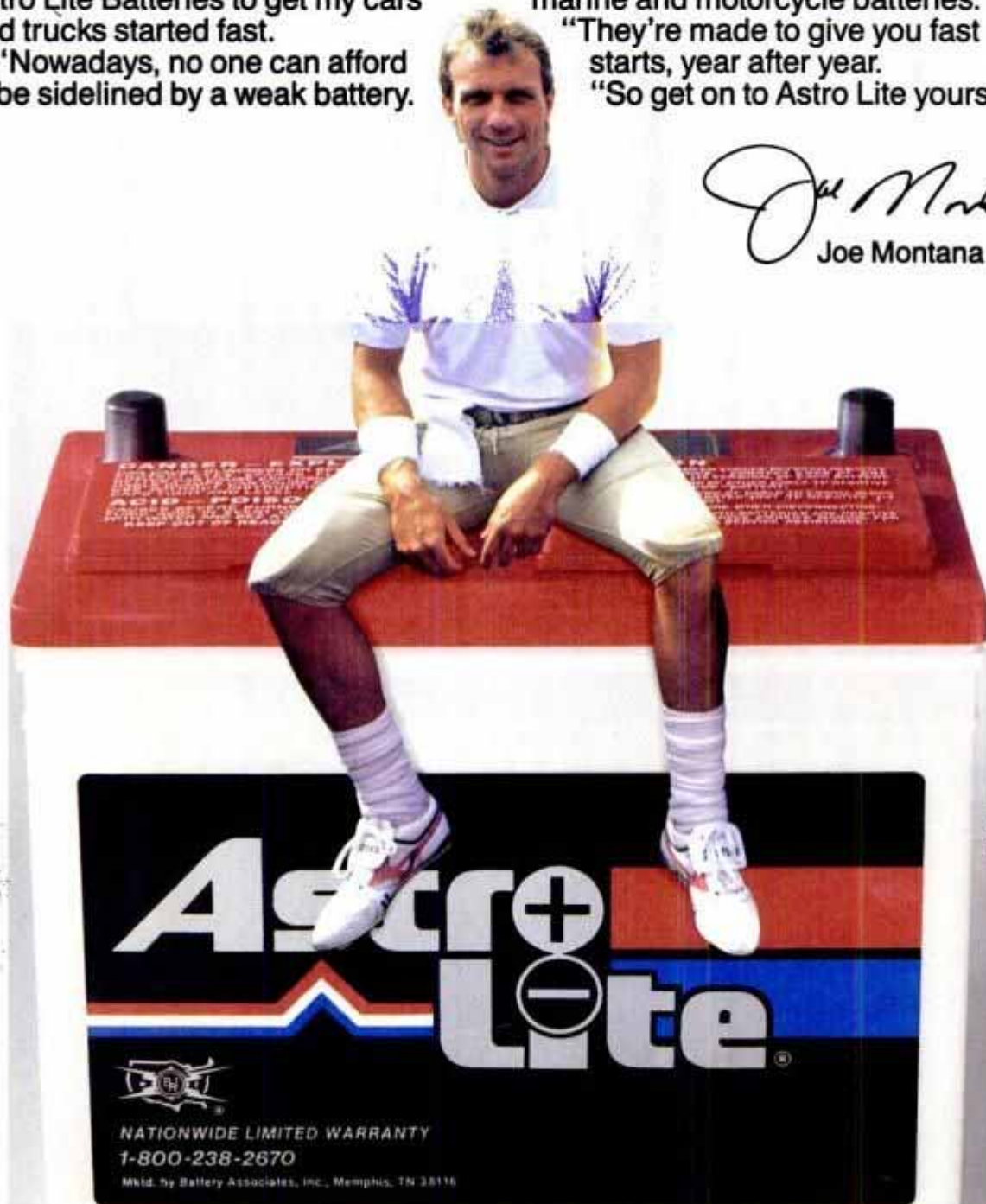
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"They're made to give you fast starts, year after year.

"So get on to Astro Lite yourself."



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25% Better Mileage Just Wasn't We Taught Our Newest Automatic



"Best-Built" claim based on an average of consumer-reported problems in a series of surveys of all '81-'90 models designed and built in North America. Sales by Division. *EPA Highway Estimates for 1991 E4OD transmission vs. '90 C-6 transmission in F-150 4x2 with 4.9L engine. Actual mileage may vary.

Enough. Transmission How To Read.



For truck buyers, a significant improvement in fuel economy is good news.*

But Ford wouldn't rest until we had turned "good" into "our best ever."

That's why we developed an advanced

Ford Trucks. The Best Never Rest.

electronic four-speed automatic transmission for light trucks with a unique sensor system, EEC-IV.

As you drive, it reads. EEC-IV continuously processes important information: the transmission temperature, the engine speed, and even the altitude.

How good a reader is it? In over a million miles of testing, this transmission demonstrated its overdrive gear durability, smoothness, precision, and, of course, its fuel efficiency, with exceptional consistency.

Wait'll you read the sticker. Check the price of a full-size Ford pickup equipped with this transmission. You'll find advanced technology can represent a surprisingly good value.



THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS
ARE BUILT FORD TOUGH.

Buckle up—together we can save lives.

Buck Smith hasn't changed his overalls since he was fifteen.



Union Made

Actor Portrayal

Buck says you don't change a classic just to change it. If you can't make it better, leave it alone.

Buck feels the same way about changing his denim overalls. They're made of 100% cotton with features like 12 oz. denim that's triple-stitched at the main seams and bar tacked at all the vital stress points. That's Carhartt tough, the longer you wear them the better they feel. As far as Buck is concerned it's the unchanging Carhartt quality that counts. The same goes for our growing line of pants, shirts, jackets, overalls and hunting wear.

Rugged as the men who wear them.™

That's why Carhartt is Buck's brand. And he's not about to change. For your nearest Carhartt retailer, call 1-800-247-2322.





AMERICA'S ENFORCER

Editor's note—As events rapidly unfolded in the early days of the latest Middle East crisis, uncertainties flourished. As the United States deployed elements of its Central Command under Gen. H. Norman Schwarzkopf, as allied Arab nations sent troops to join U.S. forces in Saudi Arabia, and as Britain and other allies committed warships to the Persian Gulf, the world held its breath wondering whether the Baghdad Butcher, President Saddam Hussein of Iraq, would dare cross President Bush's "line in the sand."

As you read this, it's a few months later and you may already know the answer to that question. But in the early days of the conflict, one hard fact stood out in sharp relief against all the question marks: The U.S. Navy's carrier-based F-14s would put the teeth in our efforts to isolate the Iraqi menace. Before the present conflict took shape, we embarked on a mission to learn more about this remarkable aircraft. POPULAR MECHANICS traveled to Miramar Naval Air Station in California, Fightertown U.S.A., to discuss fighter tactics with F-14 veterans. In El Centro, California, we flew with the cream of naval aviation—the Blue Angels, then made our way to the Mediterranean to conduct interviews aboard the USS Theodore Roosevelt, one of America's newest Nimitz-class aircraft carriers. Along the way, we discovered what it takes to operate on the front lines of a constantly shifting playing field.

BY TIM COLE

● Pilot Chip "Biff" King and Radar Intercept Officer John "Fozzi" Miller are strapped into a screaming terror called a Grumman F-14A Tomcat. The twin-engine Mach 2 air superiority fighter strains at the shuttle of cat number one on the heaving deck of USS *Theodore Roosevelt*. We are steaming "somewhere in the Mediterranean," projecting power, deterring aggression, prepared every hour of every day to sail into combat—and to prevail.

Chip's left hand advances the dual

AMERICA'S ENFORCER



FM PHOTO BY GEORGE HALL



Carrier operations sampling: top, a Tomcat with wings fully swept for speed patrols the sky above the USS Dwight D. Eisenhower, one of the latest-generation Nimitz-class carriers; above, with wings spread for maximum lift, an F-14 sprints off the foredeck of the USS John F. Kennedy; right, flight deck crew installs an air-to-air missile on an F-14's underwing launch rail; below, the Kennedy's combat information center coordinates operations aloft.



synchronized throttles past full military power into "burner," and the twin TF-30 turbofans emit a white-hot wail in response, their nozzles squeezing the thrust into a blinding venturi of fire. A final salute to the launch boss positioned in the bullet-proof bubble behind the foul line and Biff and Fozzie brace for the heart-stopping 3-second ride to TR's plunging bow.

And then they're gone.

The g-forces build in an instant, compressing the Tomcat's pilot/radar-intercept-officer (RIO) team into their ejection seats. Sometime between heartbeats, the shuttle speeds down the catapult slide, dragging the 60,000-pound F-14A with it. Its occupants feel in their guts that intoxicating mixture of sudden power—and the nerve-fraying realization of losing, then regaining, control—as the Tomcat hurtles into space toward an unseen threat approaching the carrier's fighter umbrella.

Men and machines

Biff and Fozzie—and the long-legged, superfast, musclebound aircraft they fly—are on the cutting edge of America's response to worldwide conflict. Carrier battle groups form the heart of America's maritime strategy of forward defense—placing men and machines at the epicenter of global flashpoints from the Gulf of Sidra to the Gulf of Oman off Iran. Functioning independently in international waters, aircraft carriers demonstrate resolve during the brushfire incidents that characterize our times.

The sharpest arrow in this formidable quiver is the F-14A—the Tomcat—with beyond-visual-range air-to-air missiles like the Phoenix and the all-seeing AWG-9 radar, probably the world's most formidable fighter. More importantly, for nearly two decades, the F-14A Tomcat has been the first to fight and has repeatedly proven its mettle in actual shooting incidents.

Congress has given Grumman the go-ahead to extend F-14 production with the F-14D, equipped with General Electric F110-GE-400 turbofans, a more reliable, more powerful variant. The D version's Hughes digital AN/APG-71 radar will offer faster data processing and monopulse angle tracking that will allow the F-14 to continually scan the skies for threats while maintaining positive lock-on of multiple bogies. Equipped with the Phoenix missile—and later the AIM-120 advanced medium-range air-to-air missile—the F-14D will extend the lifespan of the world's most capable air interceptor into the next century.



FM PHOTOS BY BRIAN R. WOLFF

Secretary of Defense Richard Cheney is hoping that with the addition of the new D versions, the current stable of F-14As on 14 aircraft carriers will provide sufficient firepower before the Navy version of the Advanced Tactical Fighter comes on line. McDonnell Douglas F/A-18 Hornet strike fighters have assumed a hybrid ground-attack/air superiority role, which will help ease the strain on America's readiness. But until the naval ATF becomes operational, the F-

IFF ANTENNA/UHF DATA LINK

TACAN ANTENNA/UHF COMMUNICATION

TITANIUM BOX CARRY-THROUGH STRUCTURE

FUEL TANK

REFUELING PROBE (EXTENDED)

ELECTRONICS BAY

GLOVE VANE (RETRACTED)

AMMUNITION DRUM

VULCAN M-61A1 GATLING GUN

AWG-9 ANTENNA

IR/TV OPTICAL UNIT

SPEED BRAKE

FUEL DUMP

STABILIZER ACTUATOR

STABILIZER

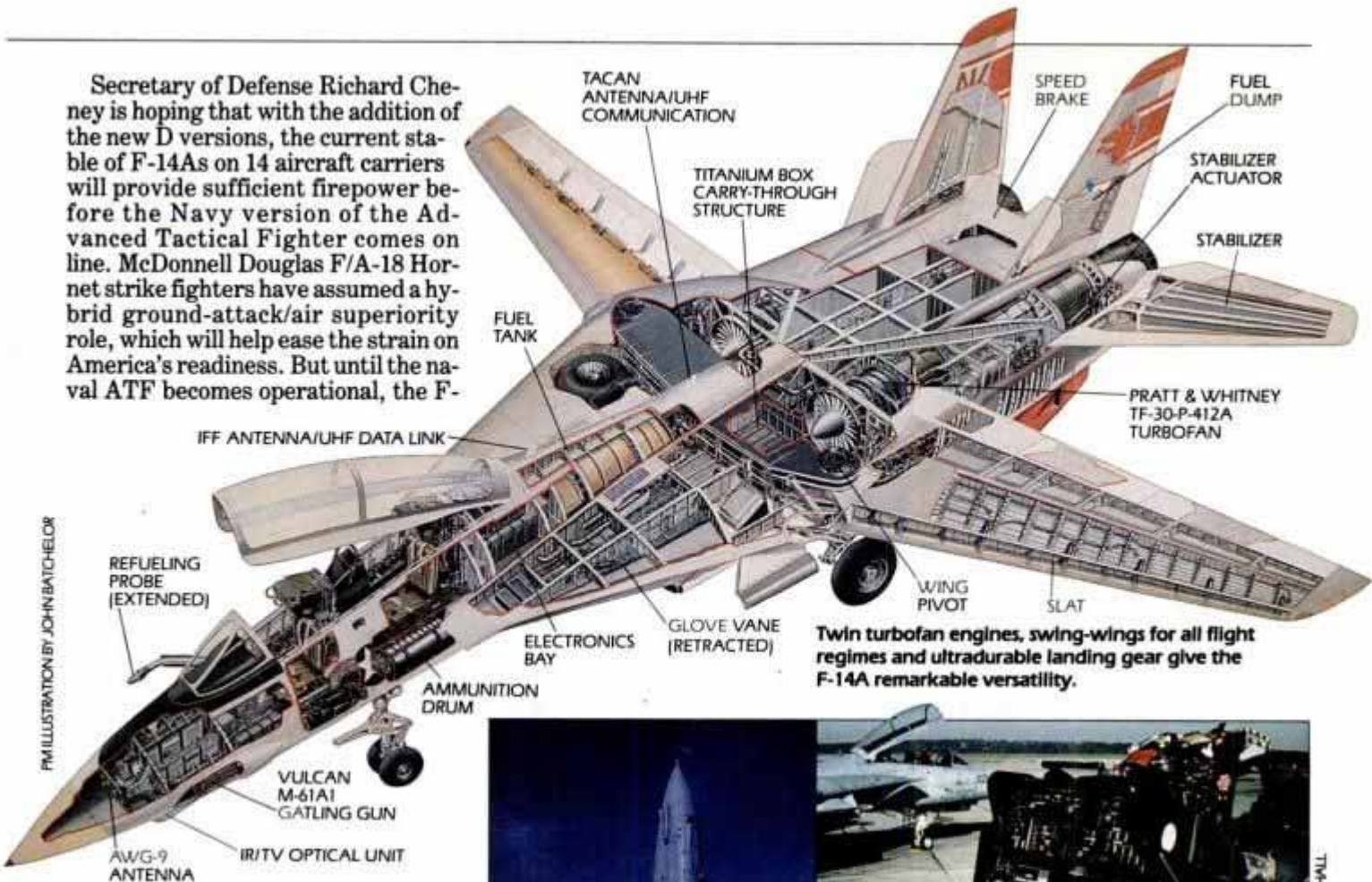
PRATT & WHITNEY TF-30-P-412A TURBOFAN

WING PIVOT

SLAT

Twin turbofan engines, swing-wings for all flight regimes and ultradurable landing gear give the F-14A remarkable versatility.

PM ILLUSTRATION BY JOHN BATH-HELOK



PM PHOTOS BY GEORGE HALL

14 will be minding the store on the world's oceans.

This task is made easier by the inherent capabilities of the F-14, a remarkable example of high-tech engineering for the purpose of defeating air threats to the carrier battle group, or providing air cover for attacking A-6 bombers.

Twin Pratt & Whitney TF-30-P-412A afterburning turbofans provide 20,900 pounds of thrust per side. A Mach 2.4 maximum speed means rapid intercepts of an incoming adversary well outside antiship missile range. A secure UHF datalink from surface-based combat information centers or orbiting E-2C Hawkeye AWACS augment the F-14A's pre-engagement and targeting prowess.

During an actual encounter, variable geometry wings, which automatically adjust to a given flight regime, add versatility through all phases of fighter flight from high-speed intercept to low-energy maneuvering during eyeball-to-eyeball dogfights. Equipped with the remarkable AIM-54C Phoenix system, heat-seeking AIM-7 Sparrow and radar-guided AIM-9 Sidewinder anti-aircraft missiles, the F-14 packs sufficient punch to destroy opposing aircraft with a single shot.

Key to this combination of a swift, nimble aerial platform and a powerful, smart missile is the proven and re-

liable analog AWG-9 radar system, which can detect and track up to 24 targets from 50 ft. off the deck to 80,000 ft. high, well beyond visual range. Handing data off to its complement of Phoenix anti-aircraft missiles, the AWG-9 can assign firing priority and unleash up to six missiles on six different targets simultaneously. This ability to strike from well outside the missile range enjoyed by most Eastern Bloc aircraft enhances the F-14's survivability so it can reload and get back in the fight. An M-61A1 Vulcan 20mm Gatling gun gives

The radar-intercept-officer position in the F-14A is a highly sophisticated nerve center for target, navigation and other data. The RIO directs the aircraft into position for weapons release prior to a dogfight.

the F-14 considerable firepower in tight, tactical engagements.

Flying the intercept

The key to this powerful weapon in America's seagoing arsenal is the pilot/RIO team that flies and fights. They act within the rules of engagement, strict guidelines that must be followed in the event of hostile contact.

"In daytime, it's not all that bad. But on a dark night in bad weather with no moon, that angled deck looks awful small on final approach. There's very little room for error. It still amazes me that we do what we do. We can launch and recover aircraft in all kinds of situations. We can even do it without communicating or radiating, which would reveal our position. No other navy in the world can do that," says pilot Chip King.

Launch, recovery and the political environment shape the essential task that confronts the pilot/RIO team. Running the actual intercept and

PHOTO BY GEORGE HALL



eliminating the threat engages their time aloft. Defeating an aerial adversary can be divided into two phases—pre-merge, or outside missile range, and post-merge, within missile and even gunnery, range. The intercept begins when the radar intercept officer in the backseat directs the pilot to fly toward the target.

Centerpiece of the backseat RIO position is the detailed data display (DDD) that offers radar and infrared target returns. The tactical information display (TID) directly below it shows computer-processed target and navigation data or television imagery if a TV sight unit has been installed in place of the infrared unit.

The TV can be aimed by the AWG-9 radar, reaching out to visually identify and verify targets before a kill.

The RIO uses a centerline joystick to direct and adjust the AWG-9 antenna scan pattern. Targets can thus be tracked while scanning for additional threats. In this pre-merge scenario, opposing aircraft can be fired upon before they come into view, well outside—some say twice—an adversary's missile range. Other factors, like precise navigation, adequate communication to shipboard command authorities, identification friend-or-foe, secure datalinks from ground or aerial sensing platforms, complicate the scenario and make any air-to-air fight a white-hot, split-second duel.

The Score So Far

Grumman F-14A (right) during Phoenix missile firing exercise.



Libyan MiG 23 (left) of the type downed in 1989.

PHOTO BY GEORGE HALL

Dogfighter

If an encounter progresses beyond the merge point, the pilot takes over to position the aircraft for a Sidewinder or Sparrow shot while the RIO "checks six," visually identifying any threats coming from behind. Using aggressive stick and rudder piloting, the front-seater uses the full range of the F-14's envelope—along with equipment like the air combat maneuvering (ACM) status panel and other instruments—to go in for the kill. ACM gives the pilot weapons status indicators, hot trigger lights and other crucial information. Most of the aircraft's visual clues during a dogfight are located on the head-up display projected on the windscreens, and the most important element of ACM is the master arms switch, which enables the aircraft's armament.

It's natural for a fighter pilot to have a special regard for the platform he drives. But F-14 pilots have a deeper affection for their steed.

As one pilot puts it, "Look at how we treat that airplane. Cat shots. Arrested landings. Thousands of them. We beat the hell out of it."

And the Tomcat—America's enforcer—just keeps on flying. **PM**

● Coming into the current conflict with Iraq, the F-14's record stood at 4 and 0 when dogfighting for keeps. But the plane has yet to find a real test of its abilities. The Soviet-built MiG 23s and Su-22s are known to be somewhat slower and less maneuverable than the F-14. And Libyan pilots are garbage truck drivers compared to U.S. Navy aviators.

The Tomcat's two most recent victories came in 1989. In defiance of Muammar al-Qaddafi's declaration of a "line of death," an American task force steamed through the Gulf of Sidra to keep international sea lanes open. Libya launched two MiG 23s at

the carrier USS *John F. Kennedy*, which sent two F-14s to intercept. After repeatedly trying to dodge the oncoming MiGs, they fired two Sparrow missiles, which sailed clear of their intended mark. The F-14s then downed the bogeys with a third Sparrow missile and a Sidewinder.

Eight years earlier, the Libyans had provoked an even more 1-sided skeet shoot, when one of a pair of Su-22s actually fired a missile at a pair of Tomcats. The response was swift and sure. One minute, and two Sidewinders later, both of the Soviet-built planes were blasted out of the sky.

—Abe Dane

BLIND TASTE TEST

Real people take the Iacocca challenge and evaluate identical Japanese and American branded cars. Guess which they prefer.

BY RICH TAYLOR, Contributing Editor; PM Photos by Humphrey Sutton

• Lee Iacocca got us into this. Six months ago, the Chrysler chairman started an advertising campaign that's still going on. Mr. Iacocca's message: "Two cars come off the same assembly line in the same American plant. A Japanese nameplate goes on one, an American nameplate on the other, and the people prefer the Japanese version! We've got to get people to wake up to the truth!"

Who could resist a challenge like that? We gathered together six pairs of cars—12 cars in all—that are built in the same factory by the same workers but sold by both an American and a Japanese company. To test Chrysler's products, we paired the Illi-

nois-built Mitsubishi Eclipse with the identical Plymouth Laser. We also paired the Eclipse 4x4 with the Eagle Talon 4x4. And we paired the Japanese-built Mitsubishi Mirage and identical Eagle Summit.

To see if Mr. Iacocca's theory holds true for other manufacturers besides Chrysler, we paired Toyo-



BLIND TASTE TEST



ta's California-built Corolla with the Geo Prizm, built on the same assembly line but sold by Chevrolet dealers. We paired the Japanese-built Isuzu Impulse with the identical Geo Storm. And finally, we paired the Canadian-built Geo Tracker sport/utility with its twin, the Suzuki Sidekick.

To test Mr. Iacocca's theory, we gathered a cross section of "real" Americans of every age, income and

education level, with a variety of automotive experience (see "Real People Test Crews," below). Twelve testers drove the cars "blind"—all the emblems were covered—and didn't know which car in each pair was which. Every tester drove a standard driving loop in each car, then filled out a rating sheet on that car, and finally, picked the one they preferred from each pair.

Our second group of 12 testers—the "branded" group—had virtually identical demographics to the blind group, but this time all the emblems were visible so that the group knew ahead of time which car in each pair was American and which was Japanese. They also drove each pair of cars over the same driving loop, filled out their rating sheets, then picked the car they preferred from each pair.

Real People Test Crews

● We managed to assemble a true cross section of American car buyers for this test—and two matching groups of them, besides. Each group consisted of six men and six women. Our "blind" test crew had an average age of 40½ years; the youngest was 25, the oldest 61. Some were single, and some were married. They had completed an average of 15½ years of schooling—college graduates, in other words—though some had gone only as far as a high-school diploma, while others pulled up the average with advanced degrees.

They drove an average of 23,330 miles per year and averaged 2.83 cars per household. Nine of them owned domestic cars, six owned Japanese cars and five owned Euro-

pean cars. One eclectic buyer owned half-a-dozen cars, built all around the world.

Among the cars these testers listed as their primary transportation were a Jeep Wrangler; Chevy, Datsun, Ford, Toyota and international pickups; a Mitsubishi Montero and 10 assorted sedans, most built by Chevrolet and Ford. Their most unusual cars were a 1974 Mercedes-Benz SLC and a '38 Plymouth sedan. In the past, they've owned a wide variety of machines, including an Austin-Healey, an AMC Javelin and a '53 Dodge Power Wagon.

Our "control" test crew also consisted of six men and six women, with an average age of 38; the youngest was 21, the oldest 61. Some were single, and some were mar-

ried. They had completed an average of 15½ years of school, drove 19,000 miles per year and owned 1.91 cars per household. Nine of the testers owned domestic cars, three owned Japanese cars, and five owned European cars.

Among the cars they listed as primary transportation were a Jeep Cherokee; Ford, Datsun, GMC and Chevy pickups; an Isuzu Trooper and nine assorted sedans, including Ford, Chevrolet, Volvo, Oldsmobile and Buick. The most unusual car was a 1958 MGA, though like the blind group, they've owned a wide variety of cars over the years, including an Aston Martin DB-6, a Jaguar XK-140 and a Sunbeam Talbot.

—R.C.T.



Everybody gets into the act in this one. Professional testers push the cars to their outer limits, while ordinary motorists rate the vehicles from their own personal perspective. Pairing GM and Chrysler nameplate vehicles against identical Japanese branded ones in "blind" comparison tests showed a preference toward the latter. But the bottom line of the whole exercise is that we beat the Iacocca challenge.

None of the testers knew the price of any of the cars—only that each pair was "competitively priced."

The results? Well, overall, our blind group preferred the Japanese versions of our test cars by 64 percent, while the branded group, which knew which cars were which, preferred the American versions by 58 percent. How do we account for this difference in preference?

Well, after debriefing our testers for hours, we concluded the difference is that a majority of our testers are patriotic American citizens. They want to buy American whenever possible, and they're beginning to turn against Japanese products. When they didn't know which nameplate a specific car wore under the tape, they most often preferred the Japanese version because of minor styling, equipment or performance differences. But when they did know the name on the hood, they were more inclined to pick the American model.

This is precisely the opposite of what Mr. Iacocca is saying. He contends that Americans think so highly of Japanese products that they'll buy a car just because it says Mitsubishi

rather than Plymouth on the hood. Our test suggests just the opposite: Americans prefer the Japanese interpretation of these cars, but they would buy a Plymouth rather than a Mitsubishi because they perceive it as an American car and want to "Buy American."

Test No. 1

Our first test paired a Toyota Corolla LE sedan and a Geo Prizm GSi. Our Corolla was a 4-door notchback, and our Prizm a 5-door hatchback. This particular Prizm also came with a slightly higher level of trim and equipment. These two cars were not identical. Many of the trim and interior parts on the Prizm were different from the Toyota. Both cars were built in the GM-Toyota NUMMI joint-venture factory in Fremont, California, on the same Toyota-designed chassis.

Our blind testers preferred the Corolla to the Prizm 8 to 3, with one "no preference." Our branded testers preferred the Prizm 6 to 5, with one "no preference." Just the opposite of what Mr. Iacocca contends. That's very interesting.

At the test track, where our own

professional racers did the driving, the two cars were as alike as two peas in a pod. Although the Prizm theoretically has an extra 28 hp in GSi trim, we couldn't find it. Most of our testers thought the Prizm was subjectively slower than the Corolla, too.

The only noticeable difference was that the Prizm was significantly faster than the Corolla in both our slalom



A cross section of buyers preferred to buy American when brands were visible.

BLIND TASTE TEST



Test car pairs included Toyota Corolla LE (1) and Geo Prizm GSi (2); Mitsubishi Mirage (3) and Eagle Summit (4); Mitsubishi Eclipse GSX (5) and Eagle Talon TSi (6).

and skidpad tests. Why? The Prizm was fitted with sticky 185/60HR-13 Goodyear Eagle GT tires, while the Corolla came with mediocre Invicta GL P175/70R-13 M+S all-season tires, which are fine on the street but slow around a test track.

Overall, both test groups thought the Corolla was "a nice, tight driving car, very responsive to the road." They also applauded the "clean, classic, almost European styling" and the "excellent quality of most components," but complained about the limited headroom, uncomfortable seats, cramped interior and the oil dipstick located on the back side of the engine. "Impossible to find," they noted, "and

when you do, you'll burn yourself on a hot engine." Summing it up: "A straightforward car with few gimmicks, but nice looks, a solid ride and quiet quality."

Our hatchback Prizm was equally praised for its road manners and build quality, but our testers found it noisier than the Corolla, "banal" in exterior styling and "impossibly cramped" on the interior. As one wit wrote, "Would make a good small family car if the back seat was big enough for children."

One design-conscious tester found the Prizm controls and instruments "an inelegant, oversized array of knobs and levers that is not only an-

noying and silly, but fraudulent." On the other hand, everybody loved the Prizm's "sexy shade of red" paint.

Test No. 2

Next we paired a literally identical Mitsubishi Mirage and Eagle Summit. Our 1990 models were built in Mizushima, but 1991 models will come from Diamond Star, the Chrysler-Mitsubishi joint-venture factory in Normal, Illinois. These were notchback sedans of about the same size and performance as the Corolla/Prizm. The only discernible difference between the Mirage and the Summit was the color.

Our testers split the difference.

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE LIST/ AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in./mm)	LENGTH OVERALL (in./mm)	WIDTH OVERALL (in./mm.)
Toyota Corolla LE	\$11,598/ \$12,707	14 DOHC, 16-valve	102 @ 5800 rpm/ 101 @ 4800 rpm	front/ front	3-speed auto	95.7/ 2430	170.3/ 4324	65.2/ 1655
Geo Prizm GSi	\$12,285/ \$14,904	96/1587			5-speed manual		170.7/ 4334	
Mitsubishi Mirage	\$9464/ \$9807	14 SOHC	81 @ 5500 rpm/ 91 @ 3000 rpm	front/ front	5-speed manual	96.7/ 2455	170.1/ 4320	65.7/ 1668
Eagle Summit	\$8895/ \$9886	91/1468						
Mitsubishi Eclipse GSX 4x4	\$16,449/ \$19,996	14 DOHC, 16-valve intercooled turbo	195 @ 6000 rpm/ 203 @ 3000 rpm	front/ all	5-speed manual	97.2/ 2470	172.4/ 4380	66.5/ 1690
Eagle Talon TSi 4x4	\$16,437/ \$20,299	122/1997						
Isuzu Impulse XS	\$11,999/ \$14,298	14 DOHC, 16-valve	130 @ 6800 rpm/ 102 @ 4600 rpm	front/ front	5-speed manual	96.5/ 2450	166.0/ 4216	66.7/ 1694
Geo Storm GSi	\$11,650/ \$12,825	96/1588					163.4/ 4149	
Mitsubishi Eclipse GS	\$14,169/ \$16,427	14 DOHC, 16-valve intercooled turbo	190 @ 6000 rpm/ 203 @ 3000 rpm	front/ front	5-speed manual	97.2/ 2470	170.5/ 4330	66.5/ 1690
Plymouth Laser RS	\$13,394/ \$15,950	122/1997						
Suzuki Sidekick JLX	\$12,299/ \$12,559	14 SOHC	80 @ 5400 rpm/ 94 @ 3300 rpm	front/ rear or all	5-speed manual	86.6/ 2199	142.5/ 3618	64.2/ 1630
Geo Tracker LSi	\$12,245/ \$14,373	96/1590			3-speed auto			



Isuzu Impulse [7] was paired with Geo Storm [8], Plymouth Laser [9] with Mitsubishi Eclipse [10], and Geo Tracker [11] with Suzuki Sidekick [12].

The blind testers favored the Mirage 6 to 5 with one "no preference." The branded group voted 6 to 5 for the Eagle with one "no preference." Mirage versus Summit: a draw.

This is as it should be, since the cars are identical except for the name badges. There's simply nothing to distinguish one from the other, and encouragingly, that's how our testers saw it. Compared to the Corolla/Prizm, however, the Mirage/Summit was definitely second rank as far as both of our test groups were concerned. "Badly made car with poor suspension and shocks" was a typical comment, along with, "Not the kind of car I would like to own, noisy and

wobbly. I wouldn't want my wife or family in a car like this."

Test No. 3

If the Mirage/Summit was a disappointment, Diamond Star more than made up for it with the 4-wheel-drive Eagle Talon TSi and Mitsubishi Eclipse GSX. At \$20,000, these were the most expensive cars tested by our group, and also the best. By far, our testers' favorites.

Significantly, these are the specific cars that prompted Mr. Iacocca's comments, and once again our results are just the opposite from his theory. Our blind group picked the Mitsubishi Eclipse GSX 9 to 0 over the Eagle Talon TSi with four "no preference," while our branded group voted a draw at 5 to 5 with two "no preference."

This would seem to indicate that American buyers prefer Japanese cars when they aren't identified as such, but prefer the American brand when they can read the nameplate.

In either case, we—and our testers—were totally taken with the 4-wheel-drive Eclipse/Talon. It does suck gas, but you get so much in return. At the track, the turbocharged, intercooled, dohc 2.0-liter zipped from 0 to 60 in just over 6 seconds and through the quarter-mile in the 15-second range at over 90 mph. Top speed: 140 mph, give or take. That's Mus-

tang GT/Camaro Z-28 territory, and absolutely remarkable performance for a 2-liter car that weighs 3100 pounds. No wonder the Talons have won just about every Showroom Stock race they've entered.

Handling with 4-wheel drive is uncanny. The Eclipse/Talon posted some of the best slalom figures we've ever seen, though the skidpad numbers were surprisingly modest given the cars' sporty natures and their aggressive Goodyear Eagle GT4 P205/55VR16 tires. Overall, our professional testers were impressed.

So were our amateurs. "Car No. 5 is flawless," wrote one impressed tester. "Perfectly assembled and a joy to drive." "Perfectly wonderful," echoed another. "Seems like an extension of my body. I wanted to go like hell!" Interestingly, all of our testers, men and women of all age groups, found the Eclipse and Talon to be desirable, with no drawbacks except the obvious one of being a sports car cramped for more than two people.

Test No. 4

Although built in the same Fujisawa factory on the same basic chassis/body/drivetrain, Isuzu's Impulse and Geo's Storm are actually quite different. The front and rear styling is totally unique to each, and the Lotus-tuned suspension on the Isuzu is, theoretically, more performance-oriented than that under the Storm.

Surprisingly, at the track the Lotus suspension made no measurable difference. The Storm and Impulse posted absolutely identical performances

(Please turn to page 124)

TRACK (in./mm)	CURB WEIGHT (lb.)	STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM
F: 56.3/1429 R: 55.5/1409	2414 2376	Power rack & pinion/3.3	F: 9.3-in. vented disc R: 7.9-in. drum
F: 56.3/1430 R: 56.3/1430	2271	Power rack & pinion/3.8	F: 9.2-in. vented disc R: 7.1-in. drum
F: 57.7/1465 R: 57.3/1455	3095	Power rack & pinion/2.6	F: 10.0-in. vented disc R: 10.4-in. disc
F: 56.3/1430 R: 55.4/1405 F: 56.3/1430 R: 55.2/1401	2411 2282	Power rack & pinion/2.9	F: 9.7-in. vented disc R: 10.1-in. disc
F: 57.7/1465 R: 57.1/1450	2745	Power rack & pinion/2.6	F: 10.4-in. vented disc R: 10.4-in. disc
F: 54.9/1394 R: 55.1/1399	2236	Manual recirc. ball/3.8	F: 11.4-in. vented disc R: 8.7-in. drum

NEW GAS: HYPE OR HOPE?

HIGHER OCTANE

HIGHER DETERGENCY

LOWER EMISSIONS

Oil companies are slugging it out with big claims about gasolines that deliver cleaner air, cleaner engines and better performance. But how much of the claims are for real?

BY CLIFF GROMER

● Call it gas without guilt. Pump up your tank with one of the new reformulated blends, and you'll not only go a couple hundred miles down the road, you'll clean up your engine and the environment too. Why, we haven't felt so global friendly since we quit using aerosol hair spray to stop punching holes in the upper ozone layer.

Right now, there are at least nine oil companies jumping on the reformulated bandwagon—the latest wrinkle in the gas wars—with brands such as Shell SU2000E and Arco EC-1. Most promise higher octane, more detergents for cleaner engines and lower emissions.

Lower emissions? Before we start handing out Sierra Club awards to the oil companies, bear in mind that big oil was feeling big pressure from Presi-

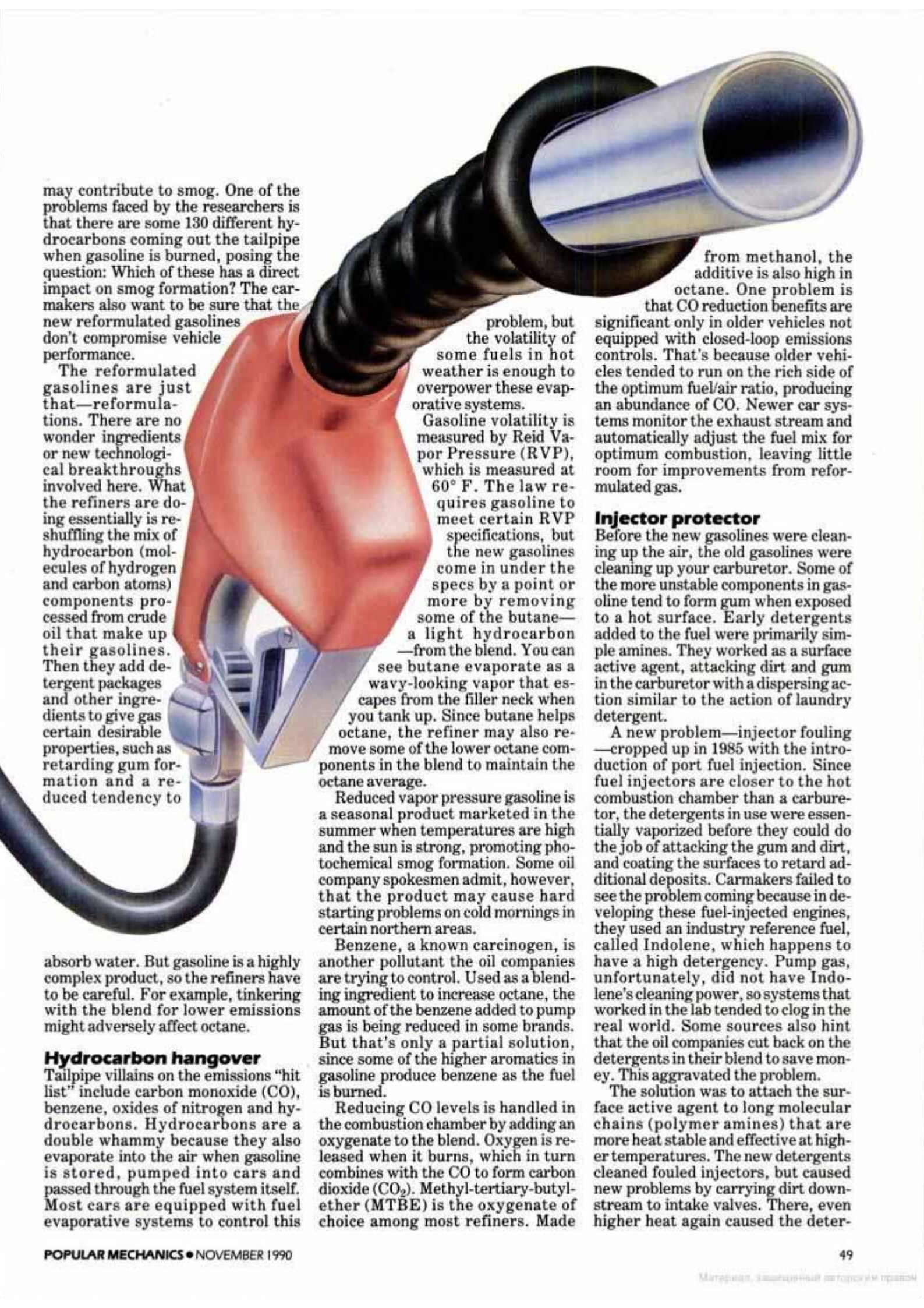


Gas stations like this now claim to dispense fuel that is more friendly to the environment.



dent Bush and Southern California regulators, among others, for cleaner-burning alternative fuels, such as methanol. Right now, a House-Senate conference committee is looking at a broad revision of the Clean Air Act, which could result in restrictions on the sale of gasoline in areas with the poorest air quality, and require carmakers to come up with alternative-fuel vehicles. Such a prospect is regarded with little joy by oil and auto interests, as both have sizable investments supporting the traditional automobile.

Fourteen oil companies and the Big Three domestic carmakers have joined forces in a multimillion-dollar oil/auto conference to evaluate a variety of gasoline blends for current and future cars and trucks, with the target of reducing emissions that are harmful in themselves or those that



may contribute to smog. One of the problems faced by the researchers is that there are some 130 different hydrocarbons coming out the tailpipe when gasoline is burned, posing the question: Which of these has a direct impact on smog formation? The car-makers also want to be sure that the new reformulated gasolines don't compromise vehicle performance.

The reformulated gasolines are just that—reformulations. There are no wonder ingredients or new technological breakthroughs involved here. What the refiners are doing essentially is reshuffling the mix of hydrocarbon (molecules of hydrogen and carbon atoms) components processed from crude oil that make up their gasolines. Then they add detergent packages and other ingredients to give gas certain desirable properties, such as retarding gum formation and a reduced tendency to

absorb water. But gasoline is a highly complex product, so the refiners have to be careful. For example, tinkering with the blend for lower emissions might adversely affect octane.

Hydrocarbon hangover

Tailpipe villains on the emissions "hit list" include carbon monoxide (CO), benzene, oxides of nitrogen and hydrocarbons. Hydrocarbons are a double whammy because they also evaporate into the air when gasoline is stored, pumped into cars and passed through the fuel system itself. Most cars are equipped with fuel evaporative systems to control this

problem, but the volatility of some fuels in hot weather is enough to overpower these evaporative systems.

Gasoline volatility is measured by Reid Vapor Pressure (RVP), which is measured at 60° F. The law requires gasoline to meet certain RVP specifications, but the new gasolines come in under the specs by a point or more by removing some of the butane—a light hydrocarbon—from the blend. You can see butane evaporate as a wavy-looking vapor that escapes from the filler neck when you tank up. Since butane helps octane, the refiner may also remove some of the lower octane components in the blend to maintain the octane average.

Reduced vapor pressure gasoline is a seasonal product marketed in the summer when temperatures are high and the sun is strong, promoting photochemical smog formation. Some oil company spokesmen admit, however, that the product may cause hard starting problems on cold mornings in certain northern areas.

Benzene, a known carcinogen, is another pollutant the oil companies are trying to control. Used as a blending ingredient to increase octane, the amount of the benzene added to pump gas is being reduced in some brands. But that's only a partial solution, since some of the higher aromatics in gasoline produce benzene as the fuel is burned.

Reducing CO levels is handled in the combustion chamber by adding an oxygenate to the blend. Oxygen is released when it burns, which in turn combines with the CO to form carbon dioxide (CO₂). Methyl-tertiary-butyl-ether (MTBE) is the oxygenate of choice among most refiners. Made

from methanol, the additive is also high in octane. One problem is that CO reduction benefits are significant only in older vehicles not equipped with closed-loop emissions controls. That's because older vehicles tended to run on the rich side of the optimum fuel/air ratio, producing an abundance of CO. Newer car systems monitor the exhaust stream and automatically adjust the fuel mix for optimum combustion, leaving little room for improvements from reformulated gas.

Injector protector

Before the new gasolines were cleaning up the air, the old gasolines were cleaning up your carburetor. Some of the more unstable components in gasoline tend to form gum when exposed to a hot surface. Early detergents added to the fuel were primarily simple amines. They worked as a surface active agent, attacking dirt and gum in the carburetor with a dispersing action similar to the action of laundry detergent.

A new problem—injector fouling—cropped up in 1985 with the introduction of port fuel injection. Since fuel injectors are closer to the hot combustion chamber than a carburetor, the detergents in use were essentially vaporized before they could do the job of attacking the gum and dirt, and coating the surfaces to retard additional deposits. Carmakers failed to see the problem coming because in developing these fuel-injected engines, they used an industry reference fuel, called Indolene, which happens to have a high detergency. Pump gas, unfortunately, did not have Indolene's cleaning power, so systems that worked in the lab tended to clog in the real world. Some sources also hint that the oil companies cut back on the detergents in their blend to save money. This aggravated the problem.

The solution was to attach the surface active agent to long molecular chains (polymer amines) that are more heat stable and effective at higher temperatures. The new detergents cleaned fouled injectors, but caused new problems by carrying dirt downstream to intake valves. There, even higher heat again caused the deter-

NEW GAS

gents to break down, leaving the valves plated with dirt.

Once again the blenders lengthened the molecular chains in the detergent package to give it the staying power necessary to carry the detergent (polybutene amines, polypropylene amines and polyether amines, to name a few) right to the combustion chamber. The latest detergent additives are able to remain liquid to flush and coat the hot valve and port areas. Most amines or additives require a high molecular weight carrier oil to carry the detergent past the intake valve. Others, like the additive Hess uses, have a long (dense) enough structure to make the trip through the intake system on their own.

Upping the octane

A third benefit touted by the new gasolines is higher octane ratings. If you've read any good pump labels lately, octane is on the way up, as oil companies fight the numbers war with their premium blends.

There is still a lot of misunderstanding about what octane really is. Octane is simply the ability of the gasoline to resist knocking in an engine of a given compression ratio. When fuel burns normally, the spark plug ignites the mixture, which burns evenly. The flame front advances from the plug tip outward in the combustion chamber, creating an even pressure on the piston as it begins its power stroke.

Knock is created when a pressure or temperature spike, or even a red-hot carbon buildup inside the cylinder, creates an independent source of ignition with its own advancing flame front. The two flame fronts collide, creating a pressure wave on the piston before its timed power stroke. The pressure tries to push down the piston while it's still on the way up, creating the knock.

In spite of the wealth of technical knowledge about fuels and the internal combustion engine, no one knows exactly what takes place during combustion. One of the current front-runner theories is the free-radical theory. It correlates autodetonation (knocking) inside the combustion chamber with the number of free-radicals flying around inside the cylinder. A radical is a molecule that is short on electrons and is looking to react with something in order to pick up electrons. As the flame front starting at

the spark plug starts to advance, it compresses the end (unburned) gas in the cylinder. The pressure and temperature keep rising on the end gas to the point where it will self-ignite if there are free-radicals present, or burn evenly if there are none.

the basic ingredient of gasoline, it is low in octane. A process called reforming converts it into high-octane naphtha. The naphtha is heated and piped into a reactor vessel under pressure. Here, in the presence of a catalyst, the larger low-octane molecules

lose some of their hydrogen atoms and change into smaller, high-octane naphtha molecules.

Another refining process, called alkylation, joins two small molecules of gas—*isobutane* and *olefin*—into one larger molecule of high-octane liquid called *alkylate* which is used as another blending ingredient to raise the octane number of the final product.

While gasoline octane can be increased by blending in these high-octane components produced by the conventional refining process, the oil companies can also add octane enhancers such as ethers and alcohols, including *MTBE*. These compounds are stable and tend to resist self-detonation and knock. They are also oxygen rich, which is a plus on the emissions side of the ledger. But they have a high latent heat of

vaporization, which means when they burn, they actually cool the charge. This also helps to control knock, but because the BTU content of alcohols and ethers are lower than that of the gasoline blend to which they're added, the fuel delivers less energy (BTUs).

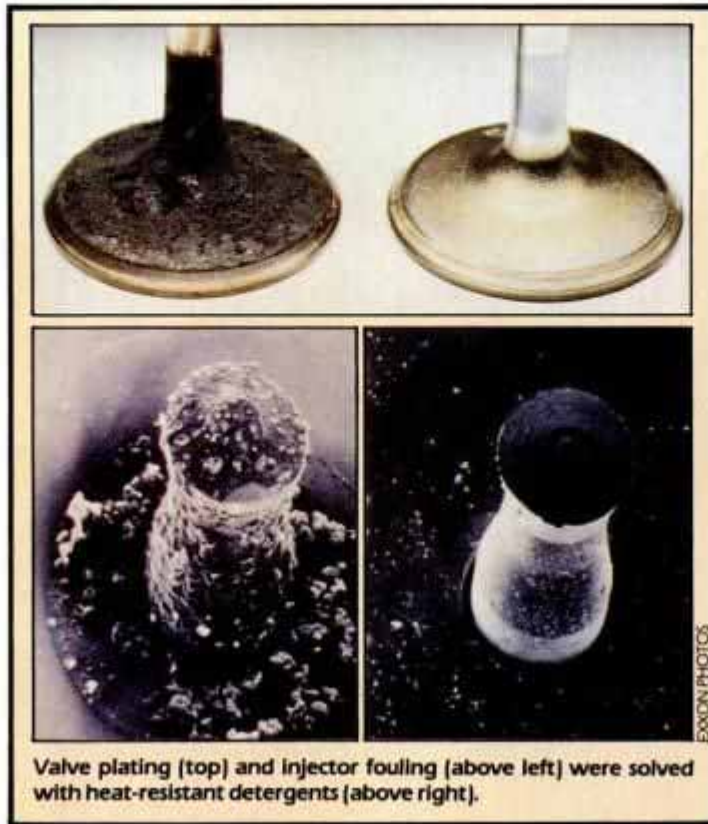
Toluene, another octane enhancer, is a pure aromatic. The chemical nature of aromatics—a stable ring of hydrocarbon molecules—makes them knock-resistant.

For the motorist, the important thing to remember is that buying a higher octane fuel than your car can use without knocking is simply wasting money.

The common belief that putting the best gas money can buy into your new car will somehow do it good only holds true if the premium blend has some other benefit, such as a detergent or reduced emissions formulation, that's not available in the less-expensive grades.

You may feel better psychologically about filling up with the best gasoline, but the competition being what it is, the other benefits of the new reformulated gasolines are being made available in the lower octane grades, as well. So you can usually feel better for less money.

PM



Valve plating (top) and injector fouling (above left) were solved with heat-resistant detergents (above right).



Independent flame fronts from premature ignition cause knock (above). To combat the problem, octane enhancers are used.

Despite the uncertainty as to the basic cause of knock, oil companies have found a variety of ways to reduce it, both in the refining process and by the introduction of additives. One technique is to raise the octane of individual crude oil components, then put them back into the blend. For example, naphtha, the same compound that is used in cleaning solvents, is one of the products that is separated from crude by distillation. While naphtha is



ELECTRONICS

STEALTH SPEAKERS

Heard but barely seen—that's the stealth loudspeaker.

BY FRANK VIZARD, *Electronics Editor*

● Music permeates the room, but it's as if some ghostly orchestra is playing the tune. The full, deep bass and the vibrant highs say you're listening to a superb audio system that's driving some sizable speakers. Yet the big, wooden speaker boxes you're anticipating are nowhere in sight.

What you're listening to is a newly

appreciated doctrine in home audio that basically says three speakers are easier to hide than two. Three-piece speaker systems, in which bass notes are handled by one speaker and the midrange and treble are reproduced by the other two, have been around for a long time. Recent improvements in design and materials, though, now

STEALTH SPEAKERS

make it possible to manufacture 3-piece systems small enough to blend unobtrusively into a room while still retaining the sonic muscle associated with larger speakers.

The cutting edge to this approach to home audio is Bose's Lifestyle Music Center listing for \$2400. While expensive, the Bose system does illustrate a direction home audio systems ap-

PHOTO BY BRIAN KOSOFF



Pattern's small speakers rotate for wider sound dispersion.

pear to be increasingly taking.

At the heart of the system is a combination compact disc player and AM/FM tuner about the size of an attaché case. This piece of electronics can be left in view or hidden from sight while still being operable, thanks to a special remote-control device. This remote uses a radio frequency to issue commands rather than the more commonly used line-of-sight infrared light beam. This RF remote can also be used to control extra amplified speakers in another room. With the Bose Lifestyle system, you can play the CD in one room while the

radio plays in an adjacent room, for instance. The additional amplified speakers raise the price of the total system by \$339 to \$2739.

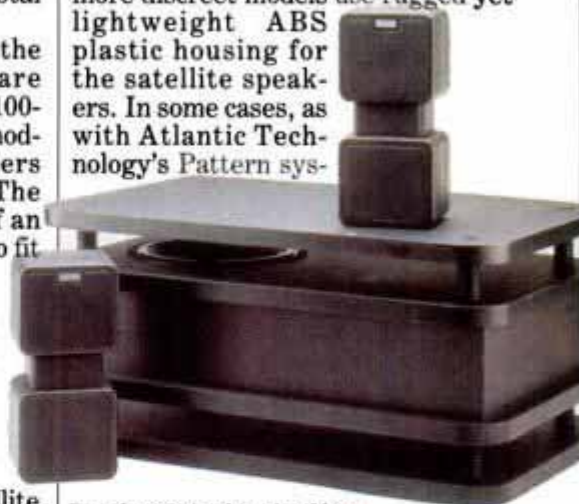
The amplifiers used to power the basic Bose Lifestyle system are strapped to the bass module. A 100-watt amplifier powers the bass module, while two 50-watt amplifiers power the satellite speakers. The bass module—about the size of an overnight bag—is small enough to fit under a table or behind a sofa. The satellite speakers—each roughly the size of a milk carton—are light enough to be mounted on walls or suspended from ceilings.

Nevertheless, you may still be surprised by the density and weight of these small satellite speakers. Sound pressure generated inside these small cabinets is often twice that of larger speakers. Rigid, dense polymers prevent the cabinets from vibrating and adding unwanted coloration to the music.

Short of a customized installation using in-wall speakers, the Bose Lifestyle system is the ultimate expression of "stealth" audio. More reasonably priced 3-piece speaker systems that are designed to interact with more conventional audio components are available from Bose and oth-

er speaker manufacturers.

Like the Bose Lifestyle system, the more discreet models use rugged yet lightweight ABS plastic housing for the satellite speakers. In some cases, as with Atlantic Technology's Pattern sys-



Panels attached to the Altec Lansing System 3 reflect low frequencies.

tem, the top and bottom portion of each satellite can be rotated on its axis for wider sound dispersion.

With the Pattern satellites, for example, you can rotate the top inward 35° to 40° relative to the bottom. If you then place the satellites on a shelf with the bottom toed slightly inward, the sound will be well dispersed.

Other makers utilize more traditional-looking bookshelf speakers with wooden cabinets that offer less placement flexibility. With these sys-

STEALTH SPEAKERS SPECIFICATIONS

BRAND/MODEL	PRICE	SATELLITE DIMENSIONS (in.)	SUBWOOFER DIMENSIONS (in.)	CROSSOVER POINT
ADC/Soundshaper 3025	\$500	5 × 8 × 4	13½ × 8½ × 14¾	110
Acoustic Research/IMS660	\$499	7½ × 4¾ × 4¾	8½ × 12 × 19	140
Altec Lansing/System 3	\$600	8½ × 4 × 3¾	9¾ × 12 × 20	180
Atlantic Technology/Pattern	\$499	4 × 8 × 3¾	19¾ × 12¼ × 8¾	100
Bang & Olufsen/Cona/CX100	\$395/\$430	4½ × 12½ × 8	10½ H, 17 dia.	195
Bose/Acoustimass 3	\$599	3½ × 4½ × 4½	8 × 14 × 8	200
Bose/Acoustimass 5	\$799	7¼ × 3½ × 4½	7½ × 12½ × 20¼	200
Bose/SE-5	\$799	8¼ × 5 × 3½	7½ × 12½ × 20¼	200
Boston Acoustics/SubSat Six	\$500	5 × 8 × 4	13½ × 16½ × 7¼	200
Cambridge Soundworks/Ensemble	\$499	8½ × 5¼ × 4	4½ × 21 × 12	140
Design Acoustics/PS-3	\$600	7¾ × 4¾ × 4¾	6¾ × 21 × 13	200
Jamo/SW-3	\$499	7½ × 5½ × 3½	7½ × 13½ × 18½	200
JBL/Proformers Plus	\$439	6¼ × 6 × 5½	7½ × 20 × 11½	125
KLH/Illusion 3	\$600	9 × 5¾ × 5½	9½ × 8½ × 14¾	150
Memtek/Triumph TS-5	\$649	7½ × 4¾ × 2¾	36 × 10 × 10	120
Memtek/Triumph TS-3	\$399	8 × 4¾ × 4¾	6¼ × 20 × 12¾	121
Polk/RM 3000	\$749	7 × 4¾ × 5½	12½ × 20¼ × 13	200
Sansui/SW-S7.7U	\$380	7 × 11¼ × 7½	19 × 9½ × 11¼	200



JBL's Proformers Plus speaker system uses one 8-in. woofer.

tems, you're more confined to the "sweet spot" formed by the triangulation of the two satellite speakers relative to the listener.

More fundamental differences exist among the bass modules. Many of the bass modules can be loosely described as bass reflex speakers. Bass reflex speakers are characterized by a small port or vent in the cabinet—a construction technique designed to yield a deeper bass sound than is normally possible with a totally enclosed cabinet. Bass reflex speakers can sound boomy—a determination to make on your own.

Alternatively, some speaker makers use what's called an acoustic suspension speaker. In this design, a woofer is loosely suspended in a sealed enclosure. The result is good accurate bass, although more amplifier power is needed than with bass reflex speakers to get the sonic kick associated with low bass notes.

Other variations are more model specific. The sonically superb Pattern, for example, has two 15-watt amplifiers for the satellite speakers and one 30-watt amplifier for the bass module. The Pattern also has three

different audio inputs so that components like a tape deck or CD player can be connected directly to it. The system does lack a remote control that could make volume, power and source selection much easier.



The woofer inside the round bass module of the B&O system fires downward, using the floor to radiate sound around the room.

A more elaborate version of the Pattern—one designed for home theater systems—is also available from Atlantic Technology for about \$1200. This home theater system includes extra speakers and a Dolby Pro Logic surround-sound decoder. The decoder allows you to access the center and rear channel information encoded on many movie soundtracks.

Cambridge Soundworks, meanwhile, uses two slim bass modules in its Ensemble model instead of one, as is generally the case. Cambridge says the two modules offer greater placement flexibility due to their slim contour. The 2-module design is also used to prevent any low-frequency cancellations that could occur when both stereo channels are routed to a single woofer. Cambridge's Ensemble system is available only by mail order—call (800) 252-4434.

Most other manufacturers avoid any potential low-frequency cancellation by using one woofer for each channel even though both are housed in the same module. JBL's Proformer Plus and Bang & Olufsen's Cona use two voice coils—the magnetized part of the speaker that precipitates the in-and-out sound-producing motion of the woofer—connected to one woofer.

The B&O Cona is a round bass module that can be disguised as perhaps a plant stand, for example. B&O's Cona woofer fires downward, using the floor as a reflective surface to disperse the sound. In all of these models, bass response generally improves if the bass modules are placed near a reflective surface like a wall or floor. Altec Lansing, in fact, attaches a flat panel opposite each woofer in its System 3 model for precisely that reason.

Another design approach is taken by Polk Audio. In its RM 3000 model, the two 6½ in. acoustic suspension speakers fire into another chamber housing a 10-in. woofer. This larger woofer acts as a passive filter to eliminate unwanted upper-bass frequencies that yield a sense of directionality to the music.

While all these approaches have their merits, the key ingredient to consider is the degree of bass directionality each model yields. While it is not a sin in and of itself, bass directionality will restrict placement of the bass module to an area near the satellite speakers in order to maintain the stereo image.

The key specification to consider, therefore, is the crossover point between the bass module and the satellite speakers. Measured in Hertz (Hz), the crossover point is the frequency above which sound is reproduced by the satellite speakers and below which sound is reproduced by the bass module. The lower the crossover point, the less likely it will be that the bass module will exhibit directional characteristics. As long as you can't tell where the bass is coming

Big Bass In A Small Box

● The real trick to a 3-piece speaker system is getting bass that sounds big, but comes from a box that doesn't take up a lot of space. Big bass generally requires big woofers in big cabinets. So what's the solution?

Credit must be given to Bose Corp. for developing current interest in 3-piece systems. While techniques do vary now, the Bose solution stimulated interest in 3-piece systems.

Bose's design for the Acoustimass 5 uses two 6-in. woofers firing into two internal chambers. The module is constructed so that the front and back of each woofer radiates sound into each chamber with its motion. The sound inside each chamber is then launched into the room via a small port. The result is bass that sounds like it's coming from a much larger speaker.



Cambridge Soundworks uses two bass modules in its Ensemble system.

from, the bass module can be hidden virtually anywhere in the room.

Add in a tiny pair of satellite speakers and you have an audio system that's virtually invisible. Furthermore, you're hearing the deep bass the music is meant to have—something most bookshelf speakers don't deliver. Enjoying good music doesn't mean adding new furniture-sized speakers into your living space. **FM**

Beware The T



It's a warning that the American Thunder Racing Team is ready once again to take on all comers in the SCORE/HDRA circuit. Because when you combine the racing experience of Mobil 1, BFGoodrich T/A Tires and Team Chevy, these American Thunder trucks strike

quicker than lightning. With Mobil 1 synthetic motor oil in the pan, dust-choked engines get extra protection to run strong and clean. BFGoodrich T/A Tires won't loosen their grip when the terra firma loses its firm. And the specially equipped Chevy C/K full-size pickups

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Thunderclouds.



and S-10 trucks are built to compete in the toughest off-road circuits in the land, like Clive Smith's specially modified 4x4 which was victorious in a record-setting performance

at this year's Pikes Peak Challenge. So harness some thunder by hooking up with American Thunder; Mobil 1, BFGoodrich T/A Tires and Chevrolet. Then get ready for one serious reign.

SCORE INTERNATIONAL / HDRA



CHEVY TRUCK

Mobil 1

BFGoodrich
Tires

LONG-TERM TEST



A new crop of road warriors joins our fleet.

● Since the last time we reported to you on our long-term test fleet, we've returned three vehicles (Mazda MPV and Miata, and Eagle Talon), one car continues in service (Cadillac Seville), and four new cars—Honda Accord EX, Chevy Blazer and Caprice, and Pontiac Trans Sport—have joined our group.

Chevrolet Caprice Classic

Sliding behind the wheel of this car reminds us of a Biblical parable: Old wine, new skins. That's precisely what the new Caprice—the same rugged body-on-frame design we've known since 1977, wrapped up in new sheetmetal—is like.

Our reaction to the new aerodynamic shape, a look conceived to carry Caprice through the rest of the 20th century, is lukewarm. To our eyes, this design seems to echo some of the styling themes of the late '40s and early '50s, and it is least successful viewed from the rear.

The feel of the car is also nostalgic, with the cushiony ride quality that was typical of big American sedans a generation back. While this is welcome enough in freeway driving, it

exacts a price in the handling department. Even though our Caprice has an upgraded suspension package, it still rolls in hard cornering, and the wheels jump around on stutter bumps. Antilock brakes as standard equipment is a commendable update.

On a more positive note, we find the Caprice's build quality to be very good indeed. The paint is first rate, with nary a ripple. The seams all match and with 3954 miles on the clock so far, New York City's mean streets have yet to provoke a single rattle.

Although the Caprice's standard 5.0-liter V8, a proven engine if ever there was one, isn't particularly impressive in passing performance, it gets this big 3700-pound car out of the blocks quickly enough and also produces surprisingly good fuel economy—17.5 mpg around Manhattan, a bit over 23 on the highway. It's also smooth and quiet in the best tradition of big American sedans.

And this is a big car, capable of swallowing six adults. There's a vast trunk to swallow the luggage that goes with all those passengers, an old tradition that will always make sense.

In fact, preservation of oldtime

American automotive traditions is what gives the Caprice its enduring place in the market. It's big and roomy and comfortable, has a smooth V8 engine, is built like a tank to absorb punishment in day-to-day use, and is put together with high-quality fit and finish. However, we feel that some elements of this tradition are due for an update. —Tony Swan

Chevrolet S-10 Blazer 4-Door

This 4x4 gets funny looks from a lot of people—sort of a what's-wrong-with-this-picture wrinkling of the forehead. They'll come over while you're pumping gas or loading groceries and remark about what an attractive truck you've got.

It's not until you've gotten a minute or two into the conversation that they realize they're looking at the 4-door version of what has traditionally been a 2-door sport/utility. And they like it—both for the utility and the lack of boxyness that the extra wheelbase adds. We do, too.

Our version has 4-wheel drive, the 4.3-liter V6, and the trailering package including hitch receiver already installed. It came in with a few hun-

CARS



CADILLAC SEVILLE STS



CHEVROLET CAPRICE CLASSIC

dred miles already racked up, and spent a month or so doing commuter service into the city from the wilds of New Jersey. In this regimen, it was fine, tall enough to see over the top of the traffic, and delivering nearly 20 mpg—good for so large a vehicle. One negative: The air conditioner was barely adequate.

Then came the need to tow a 2200-pound trailer—well under the 5000-pound trailer rating Chevrolet gives this drivetrain. Mileage plummeted to less than 10 mpg, and the throttle was floored virtually all the time. Flooring the throttle produced a lot of noise and heat, but not much in the way of added pulling power. We were

PM PHOTO BY GPHOTO



CHEVROLET BLAZER S-10



HONDA ACCORD EX

PM PHOTO BY HUMPHREY SUTTON

mighty glad to see the end of that trip.

Returned to commuter service, the Blazer seems much happier, although it's picked up a few squeaks and rattles in the minefields of midtown Manhattan.

—Mike Allen

Honda Accord EX

Name the best selling car in America in 1989. Guess again. The Honda Accord takes that honor with 362,707 units. Stunned that a Japanese car is the best-selling car in the U.S. of A.? In the first six months of the 1990 model year, the Accord again leads the sales race. One consolation: The Accord is built in Marysville, Ohio, and, so, is *almost* a domestic car.

What makes the Honda so appealing to so many Americans? That's what we wanted to know, so we asked American Honda Motor Co. to loan us a new 1990 Honda Accord EX. We picked up the car with just 6 miles on the odometer. We've now driven the car 6900 miles. And frankly, we'd still like to know what all the fuss is about. Despite an all-new Accord for 1990, we see plenty of areas where the car could still stand some improvement.

Surprisingly, our test car feels underpowered. You have to drive the car fairly aggressively to stay up with, or ahead of, the traffic flow. The trouble is, the Accord doesn't like being driven hard. It likes to loaf along, which it does without fuss.

But when you want to go, the worst of the Accord comes out. The 4-cylinder, 8-valve powerplant, rated 130 horsepower, roars in protest whenever you ask for more urge and floor the throttle. The transmission downshifts with a lurch—continually, when driving aggressively. What's

more, the car is softly suspended and rolls a lot in corners—the smallish 195/60-R15 tires roll under and squeal. At highway speeds, it is affected by crosswinds, and constant slight steering corrections are needed to keep it on course.

On the plus side, the new Accord styling is handsome in a rather bland way. The upholstery seems like it will last forever, and the seating for four is spacious and comfortable. On a 4-hour trek from New York to Washington, D.C., the form-fitting contour of the back seats kept rear-seat passengers content. And the adjustable lumbar support in the driver's seat allowed us to press on regardless, even on longer trips. When a torrential rain storm hit, the car tracked well and gave us a safe, stable feel.

With an overall mix of hard and easy driving, the Accord is averaging an excellent 23 to 27 mpg, and, mechanically, the car is bulletproof so far—with the exception of a balky driver's-side automatic shoulder belt that jams about once a week.

While we don't enjoy driving the Accord, our staff has managed to pile up plenty of miles because of the car's utilitarian value.

It's as reliable as a refrigerator—and about as much fun to drive. Maybe that's the whole key to this car's success.

—Joe Oldham

Pontiac Trans Sport

As the most exciting new shapes in the growing world of minivans, the GM-300s—Pontiac Trans Sport, Oldsmobile Silhouette and Chevrolet Lumina APV—were high on our list for a long-term evaluation.

We chose the sporty Trans Sport as

the edition best suited to our tastes, although distinctions between these three are limited to trim and subtle variations in suspension tuning.

We asked for the 3.1-liter V6 engine and 3-speed automatic trans. The V6 simply doesn't have much punch, and sounds busy in passing situations. However, it does an adequate job in freeway cruising, and better than average in fuel economy: 17 mpg around town, 22 on the interstate.

Interstate comfort is a particularly strong suit. Besides ferrying our Trans Sport from Detroit to New York, we've also recorded a weekend blitz to Toronto and back, and we can imagine the Trans Sport doing a good job of hauling vacationing families and their cargo.

That last part—cargo—is where the Pontiac Trans Sport and its GM sisters really shine. Although there are several minivans with more capacity, none can match the versatility of the Trans Sport's seating. The seats can be removed or installed in a snap, making this vehicle a superior family hauler.

In terms of quality and driveability, our impressions to date (4457 miles) are generally positive, although the logbook does show a couple of quibbles. First, the sliding door on the right side has developed a persistent and irritating rattle. Second, the transmission's column shifter is far too difficult to operate on the fly. Downshifts are particularly dicey.

Our initial impression of the GM-300 vans was that the long snoot and sizable A and B pillars would make driving tricky in heavy traffic, but familiarity has largely eliminated this concern. The side mirrors do a good



PONTIAC TRANS SPORT

job of covering the blind spots, and no one has had any real problems figuring out where the end of the van is.

The Trans Sport's overly large turning circle, however, is something no one has gotten used to, and is a drawback to the van's maneuverability in tight quarters.

For all that, we like this swoopy new minivan. We like its bold shape

and Pontiac touches with the trim. And the versatility afforded by the easy removability of its seats makes up for other faults. —*Tony Swan*

Cadillac Seville STS

The '90 Cadillac Seville in our test fleet just seems to get better and better. And more fun to drive. The willing 4.5-liter V8 makes 180 horse-

power—more than enough to make any trip a memorable driving experience. Teamed up with the fat tires, responsive handling and leather interior appointments, the Seville STS is a great place to spend an afternoon.

Despite our enthusiasm, the STS is not perfect. But then again, what car

(Please turn to page 138)



EAGLE TALON TSi-AWD

COASTAL RUN

Miami to New York—1500 miles of Intracoastal Waterway in a 22-ft. outboard.

BY JOE SKORUPA, Boating/Outdoors Editor



Mangroves line the Waterway banks in Georgia (right), a ubiquitous marker with a grateful osprey nest in Florida (left), and running Miami's Government Cut (below right).



PHOTO BY JOE SKORUPA

● Two Marines flag us down on the border of Camp Lejeune, in South Carolina. Copilot John Wooldridge and I are in our fourth day of an Intracoastal Waterway run from Miami to New York. We've been stopped by Marine authorities before, but never by *Marines*. The Corps is conducting gunnery exercises nearby. Orders say we wait.

After a brief delay, the leathernecks yell, "All clear, sir!" and we roar off in our 22-ft. Larson. Past Morehead City, we enter the wide mouth of the Neuse River and the wind suddenly picks up to a nasty 20-knot blow. We fight our way through a crackling electrical storm in Pamlico Sound, a downpour in Albemarle Sound and a change in wind direction to an unpleasant beam sea before reaching Norfolk, Virginia.

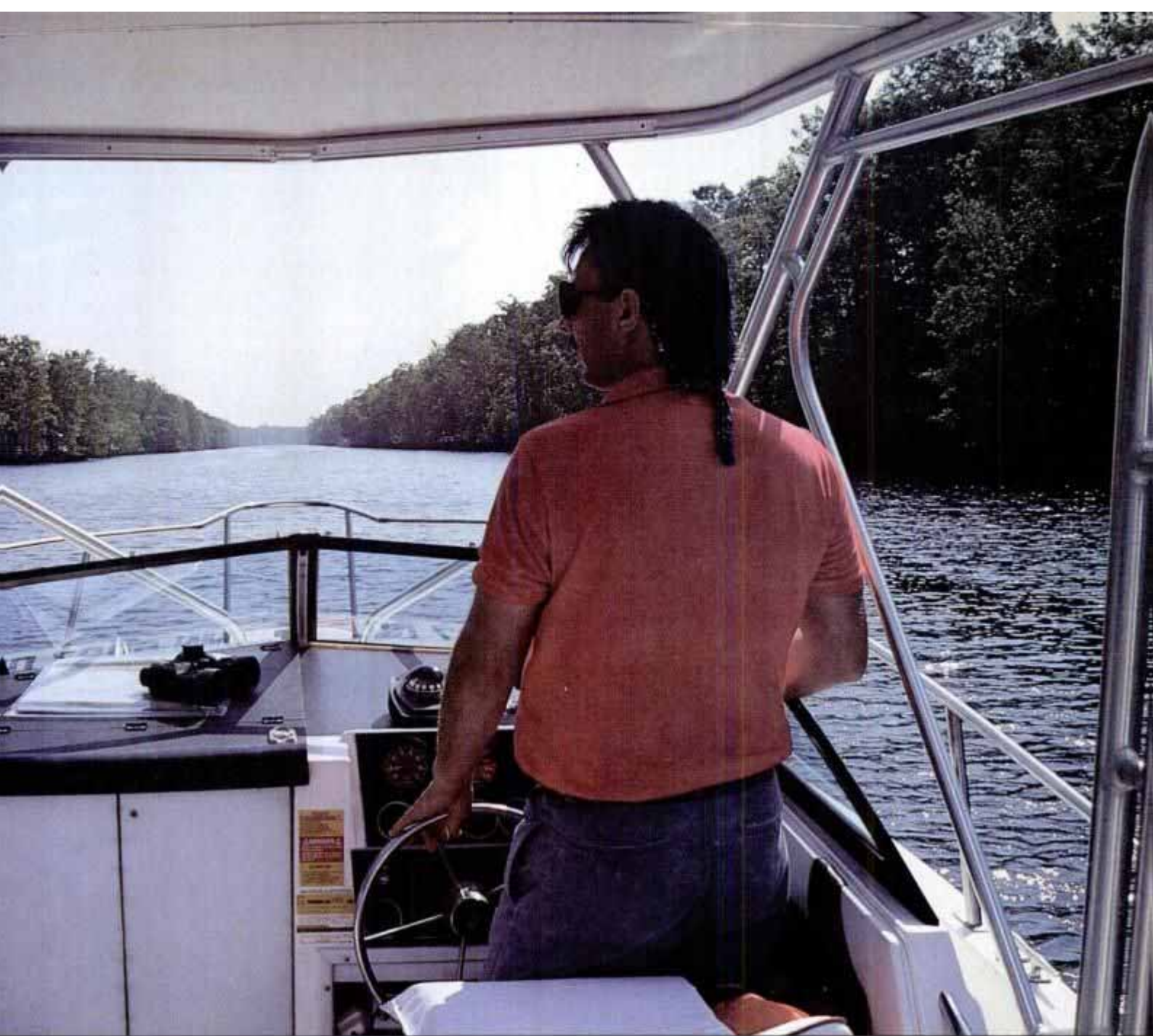
On the morning of the sixth day, we point the Larson up the Chesapeake Bay. The relentless blast changes direction again and now hurls 5-footers directly in our face. Five hours and only 50 miles later, we claw into a marina for gas. As we idle back into the churning froth, John zips up his rain gear and says, "We're going to get our butts kicked."

Interstate boatway

The amazing thing about the Intracoastal Waterway, the long blue highway that runs along the Atlantic coast, is that so much of it is protected. With a little help from the Army Corps of Engineers, nature formed a 1000-mile boat channel, from Miami to Norfolk, inside a nearly seamless string of barrier islands. North of this point, it's not quite as sheltered, but, under favorable conditions, it can be relatively tame. The route leads through the Chesapeake Bay, the Chesapeake & Delaware (C&D) Canal, the Delaware Bay, a barrier-island network in New Jersey and, finally, New York Harbor. The only true ocean running is the last 50 miles, from Jersey's Manasquan Inlet to the Big Apple.

My idea was to make the 1500-mile trip in the kind of boat I usually drive: a compact, trailerable outboard. I wanted to prove that big dreams are still possible to those who drive small boats. Also, I wanted to wring out a boat the way few people get a chance. I'd compress a season's worth of boating in a short period of time and really see what it's made of.

The boat I selected was the Larson International 228



TOP PM PHOTO BY JOHN WOOLDRIDGE, BOTTOM PM PHOTO BY BRIAN KING

INTRACOASTAL WATERWAY

—a walkaround cabin, offshore fishing machine. It satisfied all my requirements: 1. At 22 ft., it's one of the smallest boats of its type on the market, 2. The cabin is big enough to hold a week's gear, 3. The sturdy transom can handle twin 120-hp Johnson outboards, and 4. The hull is able to slice smoothly through rollers and throw water away from the helm. Add-on equipment included a sturdy welded-steel T-top with a snap-on



The long blue highway (left), loading gear at the start in Biscayne Bay (above), aground at low tide in Georgia (right), and a swinging bridge so low, on the North Carolina border (below), that even our 7-ft. boat couldn't go under it.



curtain, a compass, a VHF radio, a loran and a depth sounder. *Waterway Guide Chart Books*, binoculars, an Impulse handheld radio, Shimano rods and reels, and Omega foul-weather gear were also essential items.

John and I brought the Larson to Miami on a calm, sunny day in July. The long blue highway beckoned early the next morning.

The no-wake zone

We get a late start due to a photo session and rain showers, but once un-

derway, we crank up the engines and fly. The Larson is loaded with more than 1000 pounds of gear, but it still zips along at 42 mph. Optimistically, we set Daytona Beach, 225 miles away, as our goal for the day.

The official starting point is Government Cut in Biscayne Bay, home of monster cruise ships. Because of the storm, we take the inside route. Frequent no-wake zones in Hollywood, Fort Lauderdale, Pompano, Palm Beach and dozens of other overdeveloped communities reduce our speed to 5 mph. They're intended to prolong the life of man-made structures built on wetlands, but they just slow down the inevitable. And us, too.

We break out of the urban sprawl north of Stuart and roar full throttle for the last 2 hours. Our haven for the night is a tiny marina in Sebastian, well short of Daytona. Total distance covered is a slim 135 miles.

Day Two dawns bright, cloudless and calm. We leave the layer-cake condos and high-rise hotels far behind and enter what remains of old Flori-

da. Instead of muscle boats and Mediterranean palazzi, the sights here are clean water, mangroves, palms, blue herons and ospreys. We rarely see another boat. In 10 hours, we cover 210 miles.

We spend the night on historic Jekyll Island. In the morning, we find the Larson sitting on the marina's muddy bottom. An hour later, the tide comes in and we push the boat to deep water. From here, it's a high-speed, 250-mile run to Georgetown, South Carolina. Long gone are the semitropical mangroves and palms. This stretch of Waterway is all pine forests and sawgrass. It's virtually undeveloped, and we encounter no more than a handful of boats all day.

A stiff wind builds throughout the day after leaving Georgetown, but it's not a problem. This section, along with Florida, is among the most sheltered of the Waterway. It's also home to the cleanest aquamarine water





Lady Liberty raises a torch to us in New York (above), a Navy mothball fleet in Norfolk (left), and preparing to pull-start a trusty engine with a temporarily misbehaving starter (below). The engine later fixed itself.

PM PHOTO BY JOE SKORLIJA

found anywhere. The only time the wind bothers us is in wide river mouths.

Although the temperature hovers around 100° F, the Larson's T-top saves our hides from the baking sun. At 40 mph, the breeze keeps us cool.

Enter the Marines

With the faint booming of Marine Corps gunnery practice ringing in our ears, we battle our way into the town of Oriental, North Carolina. The wind at our back is now up to 20 knots, and the chop, at the head of Pamlico Sound, is running 4 ft. Distance traveled on Day Four, however, is a respectable 218 miles.

We cross the Pamlico and Albemarle sounds in heavy weather and big seas. At one point, we play cat and mouse with lightning bolts. We make only 160 miles and wind up in Norfolk, but consider ourselves lucky.

On Day Six, we get our butts kicked. Overnight, the wind changes



PM PHOTO BY BRIAN KING

direction to blow directly in our face. We make just 50 miles up the Chesapeake in 5 hours of hammering. After a gas stop, the wind picks up a notch and we rollercoaster through tightly spaced 5-footers. We quarter the waves and give the throttles a workout, but still drop so far into monster troughs that green water frequently

breaks over the bow. It doesn't take us long to realize we're in a no-win situation. We turn around and barely make it back to the marina at Windmill Point, Virginia. We started out like cocky sea dogs, but as we wait a few days for the weather to change, we feel more like whipped puppies.

The Chesapeake never really lays down until the middle of the seventh running day. In the morning, it takes us 6 hours to go 50 miles. But finally, the wind and chop relent. We make a 75-mile run to Georgetown, Maryland, in less than 4 hours.

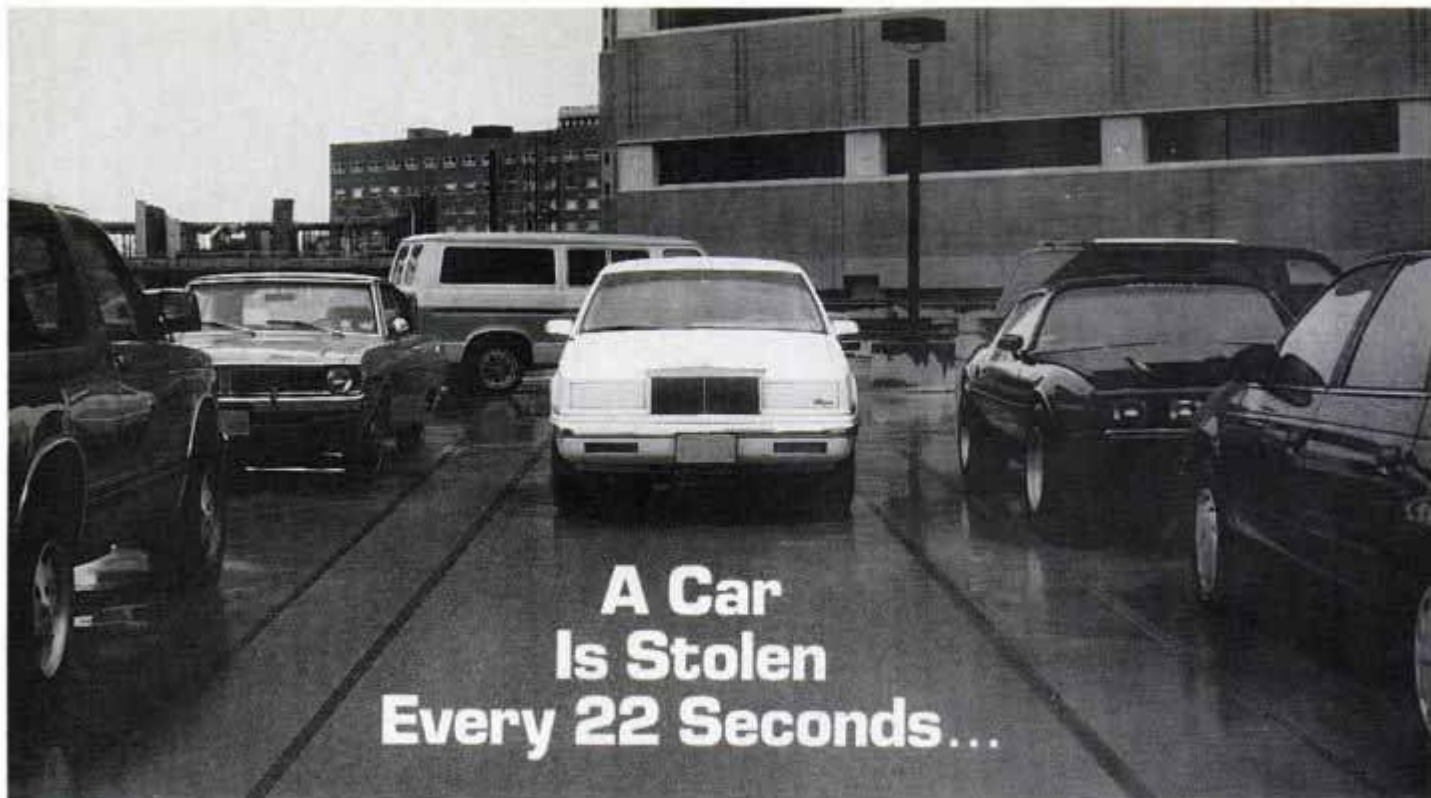
From Georgetown, it's about an hour to the C&D Canal, which takes us to Delaware Bay. The Delaware leads to Cape May, New Jersey, and opens directly onto the Atlantic. But luck is again with us. For the first time, we're completely out of sight of land and riding deep-ocean rollers, but the Delaware is a pussycat. We cross it in a couple of hours and head up the Jersey coast on the inside route.

No-wake zones, again, rear their ugly heads. In fact, Jersey's shallow, twisty Waterway actually resembles the urban congestion of South Florida. We spend the last night in Atlantic City and stay at the Trump Castle & Marina. The Donald himself sits next to us at dinner, eating at a place he owns to save money, no doubt.

On the ninth and final day, we run the last of the inside route and head out the Manasquan Inlet. Wind and luck are still with us. It takes only a couple of hours to blast through the 3- to 5-ft. swells of the Atlantic. A feeling of incredible elation sweeps over

(Please turn to page 138)

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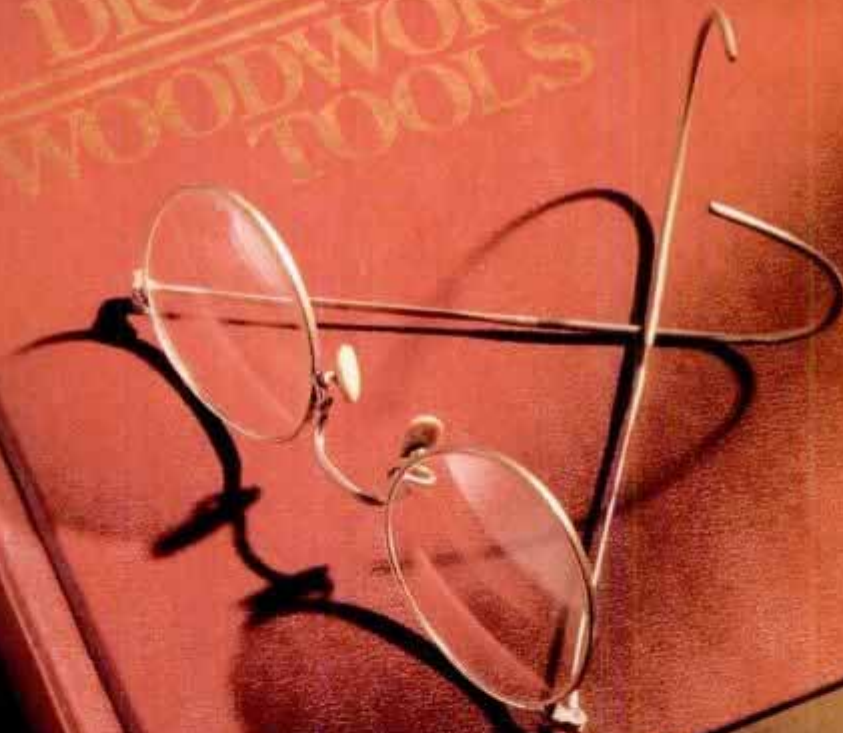
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Popular
Mechanics
DICTIONARY
OF
WOODWORKING
TOOLS



TEXT BY THOMAS KLENCK
PHOTOS BY ROSARIO CAPOTOSTO

PHOTO THIS PAGE: SPENCER JONES

A

AUGER BIT

You'll recognize an auger bit by its characteristic helical body that's designed to carry the shavings out of the hole. The standard type has a threaded lead screw at the tip that draws the tool through the wood as radial cutting edges do the actual cutting. Typical bits have a single helix that goes around a solid core. Scotch pattern bits have a double helix. Ship augers and car bits are long augers with helical bodies that wrap around a hollow center. To reduce wandering, ship augers often lack the lead screw. Augers bore holes from 1/4 to 2 in. in diameter, and common sizes cost about \$10.



AWL

Use this simple tool to locate a hole position for drilling, create pilot holes for small screws, punch holes in leather, paper and similar materials, widen and clear small holes, and for hundreds of other situations. With its round, tapered blade carefully sharpened to a fine point, it's also great for scribing layout lines. Awls are available at most hardware stores and hand tool dealers for just a few dollars.



B

BACKSAW

For cutting tenons, dovetails, notches and just about any other standard joint, traditional woodworkers turn to the backsaw. Featuring a rectangular blade, this saw has a heavy steel or brass spine that runs along the top of the blade to keep it straight and provide stiffness. It has a standard D-handle, and in the larger sizes, is often used in a miterbox. Smaller backsaws have inline handles, and are called dovetail saws. Backsaw teeth are



sharpened for crosscutting, although the saw is used both with and across the grain. While they range in size from about 8 to 30 in. long, the common sizes have a 12- or 14-in.-long blade and 13 or 14 tpi (teeth per inch). Better quality, average-size backsaws may cost over \$50, while garden-variety tools go for as little as \$10.

BAND CLAMP

Most people discover the band clamp when it's time to reglue a traditional spindle-frame chair. It's simply the only clamp that can draw those legs together uniformly and without marring. It's also great for holding together the components in contemporary cabinet construction and is often used in conjunction with plate joinery for an ultrafast assembly system. For handling mitered frames, some band clamps come with corner pads to protect the frame corners from being damaged by the band as it's tightened. A typical model may feature a 15-ft. nylon band and ratchet tightener for about \$12. Heavy-duty canvas band clamps are also available.



BAND SAW

If you're only going to own one stationary power saw, many would argue that it should be the band saw. It won't produce as fine a cut as a table saw, but has a greater cutting capacity, cuts with less effort and handles both straight and curved cutting jobs. A popular 14-in. size (distance between the frame and blade) will cut stock up to 6 in. thick, and most saws will accept a miter gauge and rip fence. For resawing and other straight cuts, use a 1/2-in. blade. Switch to a 3/4-in. blade for cutting curves, and install a 1/16-in. blade for tight scrollwork. The common 2-wheeled version shown has a tilting table for bevel cuts. Three-wheeled versions boast a smaller size and larger throat depth. Also available is a tilt-frame band saw for cutting bevels on a level, fixed table. Most common 12- and 14-in. band saws range in price from about \$300 to \$600.



BAR CLAMP



A bar clamp is the tool that's used for spanning large assemblies, drawing components together and holding them in place until the glue sets. They're generally available in sizes from 24 to 60 in. long. The standard type features a fixed head section that contains a threaded clamping assembly and a sliding section that's either locked in position with a pin or a jamming mechanism. In addition to the steel-bar type, light-duty aluminum bar clamps are available, and you can buy separate clampheads that mount on a hardwood bar. The best steel bar clamp isn't cheap—expect to pay about \$50 for a 4-ft. model.

BELT SANDER, PORTABLE

In skilled hands, the belt sander can smooth and level broad surfaces faster than any other portable power tool. Designated by the width and length of the sanding belt, belt sanders range in size from 1 1/2 x 21 in. for small, detail work, to 4 x 24 in. for large surfaces. Sanding belts for most units come in grades ranging from 36- to 150-grit for handling nearly any surfacing chore. Many models are available with optional accessories, such as a sanding frame that fits around the base to prevent gouging the wood and a belt sander stand that holds the tool upside down on your bench for small work and tool sharpening. Most tools also have a dust collection bag. Belt sanders range in price from about \$50 to \$500, with \$150 being average.



BENCH DOG

Truly a woodworker's best friend, these bench dogs can turn your workbench into a versatile stock-holding and clamping tool. They fit in holes cut through the benchtop, and, in conjunction with your vise (metal woodworking vises usually have a built-in dog), allow you to hold stock as long as your bench. The typical square, steel-type shown costs about \$27 per pair.



BENCH GRINDER



Although any shop will find hundreds of uses for a bench grinder, the foremost use in most woodworking shops is tool sharpening. The standard, 2-wheel bench grinder (shown above) comes with a fine and a coarse aluminum-oxide wheel. The most common wheel sizes range from 5 through 8 in. in diameter, with the 6-in. size being typical for small shops. Special wheels include white aluminum-oxide, which runs cooler and eliminates tool burning, and silicon-carbide for touching up carbide-tipped tools. Also available are wire wheels and buffing wheels for cleaning and polishing. For truing your wheels and keeping them clog-free, use a star-wheel dresser. Bench grinders start in price at about \$25, with typical 6-in. models costing less than \$100.

A new type of bench grinder is the water-cooled whetstone grinder (shown at left). This type of grinder features a slowly rotating (about 500 rpm), horizontally mounted, water-stone wheel. A continual flow of water across the stone face keeps the tool cool and cleans the stone surface to eliminate clogging. The interchangeable wheels are available as coarse as 100 grit, with 1000 grit being standard. 6000- and 8000-grit wheels can be installed for the finest polished edge. These grinders can be fitted with toolrest accessories for maintaining consistent bevel angles and for sharpening jointer and planer blades. Several models of water-cooled whetstone bench grinders are available with prices ranging from about \$200 to \$750.

BENCH PLANE

The standard metal bench planes used to straighten, flatten and smooth surfaces and edges are still based on designs developed more than 100 years ago, and are designated by traditional names and numbers. Each plane type is not only differentiated by its size, but in how it's tuned up and adjusted



for its specific purpose. In general, the longer the plane, the more suited it is to producing a perfectly flat surface. The smaller versions (Nos. 03, 04 and 04½) are called smoothing planes, and are generally used for final dressing and light, careful trimming. The intermediate jack planes (Nos. 05 and 05½) are usually set aside for preliminary surface work, and the longer fore plane (No. 06) aids in accurate flattening. For truing the longest edges and surfaces, use a jointer plane (Nos. 07 or 08). Prices vary widely, but a good No. 04 plane should cost about \$60. Traditional wooden planes both with and without adjustment mechanisms are available.

BENCH SANDER

Although there are disc sanders and belt sanders available as separate, stationary machines, most small shops find combination units fill the bill. The disc sander half generally has a 6- to 10-in.-dia. sanding disc with a tilting table for sanding bevels and miters. And there's usually a miter gauge for holding your work against the disc at a consistent angle. Four- to 6-in.-wide belt sanders handle edge sanding and small surfacing jobs. The belt sanders often feature an adjustable fence to position the work properly, and can be adjusted to either a vertical or horizontal position. For detail work, contouring and tool sharpening chores, a 1-in.-wide belt sander similar to the model shown is popular. Typical light-duty combination machines cost between \$100 and \$200.



BLIND NAILER



Wood filler may be the most common way to hide finishing nails, but it certainly isn't the neatest way. For an invisible nailing job, try using a blind nailer. The job of this tool is to lift a small chip of wood so that it can be pulled back to install the nail. The chisel-type cutter is locked into the tool base with a clamping screw. Simply pushing the tool into the wood with hand pressure creates the chip. After the nail is driven and set, the chip is simply bent down and glued back in place. It costs about \$15.

BLOCK PLANE



While generally considered a type of bench plane because it handles surfacing jobs, the block plane is unique in both design and use. The blade is installed bevel-side up, and therefore has no cap iron that normally helps to reduce tearout in a standard plane. The better block planes, however, do have an adjustable mouth to suit fine or coarse work. Block planes typically have a low blade angle to encourage more of a slicing cut and provide extra resistance to chattering. The standard block plane blade angle is 20° and the low-angle plane blade is set at 12°. Primarily suited for end-grain work, full-featured block planes range in price from \$30 to \$50.

BOW SAW

Woodworkers did cut curves before band saws were invented—and they probably used the bow saw to get the job done. In this saw, the narrow blade (about ¾ in.) is held at the ends of two side arms. The arms can pivot at a center rail and the blade is tensioned by a twisted cord secured to the tops of the arms. The blade can be pivoted to shift the frame position when necessary. Larger saws of this type are called frame saws. With heavy blades, they're suitable for ripping and crosscutting. Prices range from about \$30 to \$80.



BRACE



This cordless drill/screwdriver never needs recharging. It has a ratchet for use where the frame can't be rotated 360°, and a chuck that handles both taper-shank and standard, round-shank bits. For effortless screwdriving, slot and Phillips-head bits are available. Brace size, commonly 6, 10 or 12 in., refers to the amount of space required to swing the frame 360°. A 10-in. model can cost about \$70. For working in tight spaces, a joist brace has a single, lever arm rather than a frame.

BRAD POINT BIT

Because most standard twist drills are actually designed for metalwork, they can produce less than satisfactory results, such as wandering and poor entry and exit cuts. Brad point twist-drill bits are expressly designed for woodworking. They have a uniquely shaped tip that features a central point. The point easily centers the bit and controls bit skating and wandering. Brad point bits also have raised cutting edges at the circumference to ensure a cleaner hole on both faces of the board. A set of seven brad point bits from 1/8 to 1/2 in. can cost from about \$17 to \$50, depending on quality. Extra-long brad point bits and carbide-tipped versions are available.



BRAD STARTER

Often, brads are the most effective way to join small components. Their small size, however, can make installing them difficult. When you really get tired of missing the brad and catching your fingers instead, you're probably ready for a brad starter. It features a magnetic barrel that holds 16- to 19-gauge brads and finishing nails up to 1 in. in length. To use it, insert the nail in the tool and then press the nail partially into the wood. You finish the job with your hammer. Brad starters cost about \$4.



BULLET POINT BIT

Take a good close look at the tip of an ordinary drill bit and you'll notice that the very center of the point isn't capable of effective cutting. It rather pushes its way through as the adjacent cutting lips remove most of the waste. Machinists overcome this problem by first using a pilot bit that bores the area that the larger bit can't handle well. The Bullet Point bit, made by Black & Decker, incorporates a pilot bit at the tip so that the pilot hole and the finished hole are completed in one operation. The pilot-bit design also reduces skating when starting holes in metal without a center punch. In addition, the main cutting edges are higher at the circumference which helps to cut cleaner at bit entry and exit. They range in size from 1/16 to 1/2 in. in diameter and cost \$15 for a set of eight.



C

C-CLAMP

Although less popular for woodworking than the fast-acting clamps, C-clamps are a time-honored tool for holding work in place. They're designated in terms of maximum opening and throat depth, with the smaller sizes and those having deep throats being more useful in woodshops. For durability, look for clamps with square threads. For light-duty applications, fast-acting C-clamps have levers that can be disengaged to quickly adjust the opening. An 8-in. clamp costs about \$20.



CABINET SCRAPER



Scraping wood is an excellent way to produce a smooth surface. This tool holds the scraper blade in place at the correct angle and depth. In addition to smoothing, it can be used to remove excess dried glue or an old finish. The version shown costs about \$25. Scraper planes work on the same principle, but look more like a plane—a handle behind the blade and a knob in front. This type has an adjustable blade angle and costs about \$65.

CALIPER

Calipers are absolute necessities for accurately measuring and sizing lathe work. The two most common woodworking versions are the bow-type, outside and inside calipers. Both have spring-tensioned legs that are adjusted via a small wheel and screw mechanism. As their names imply, these calipers measure outside and inside diameters. Both types are generally available in sizes of 4, 6, 8, 10 and 12 in. (leg length). The maximum caliper opening is slightly more than the leg length. An



8-in. inside or outside caliper costs about \$12. If you're interested in accurately measuring as fine as .001 in., slide calipers are useful. These come in several varieties including the traditional vernier caliper, dial caliper (shown below) and relatively recent digital-display calipers. Slide calipers are also offered for metric applications. Inexpensive versions suited to most woodshops have a vernier scale that measures to 1/128 in., and cost about \$7.



CAM CLAMP

If you need clamping capacity, but don't need the power and weight of heavy steel clamps, then perhaps these light-duty cam clamps will do the job. Similar to other fast-acting clamps, they have a steel bar and wood jaws, but feature cork faces on the jaws to protect your work from marring. Pressure is exerted by flipping open the cam lever after the jaw has moved into position against the work. They'll exert up to 300 pounds of pressure and come in sizes ranging from a 7 3/4-in. to a 31 1/2-in. bar length. The largest size is about \$15.



CARVING PLANE

These small tools answer the need for fast, controlled stock removal on contoured surfaces and carvings. Their small size (less than 6 in. long) makes them easy to hold with one hand, and they're available in round- or flat-bottomed styles for handling both convex and concave surfaces. The length of the sole is about 7/8 in. and the blade width is 3/4 in. A carving plane like the one shown costs about \$16. Slightly more planelike in appearance, but handling similar carving and shaping chores, are miniature planes called violin planes. These range from 1 to 2 5/16 in. long with blade widths from 5/16 to 7/8 in. They can be equipped with standard or toothed blades and have a screw-type blade locking mechanism. The smallest plane costs about \$30.



CARVING TOOL

To the uninitiated, learning about carving tools is almost as intimidating as mastering woodcarving itself. And in the broadest sense, carving tools range from jackknives to flexible-shaft power tools and even chain saws. Most of us, however, think of the standard carving chisels and gouges when we think of woodcarving, and there are several of these kinds of tools that are basic. The carving chisel has a straight cutting edge that's either square to the sides or ground at about a 23° angle. The basic gouge has a curved cutting edge and straight sides. Bent gouges are curved along their length to handle hollowing jobs. Spoon gouges enable hollowing in tight areas and backbent gouges have a reverse bend along the tool length for shaping hollows around a convex surface. The degree of curvature on any gouge is designated by a number—the higher the number, the tighter the curve. Veining tools are actually small, straight gouges, and parting tools cut a V-groove. Fishtail tools can be either straight or curved like gouges and have splayed sides for working into corners. Macaroni tools cut rectangular channels. You can buy a set of six beginner-level tools for about \$25 or spend over \$300 on a professional set of 18 tools.



CAT'S PAW

Also called a cat's claw, nail claw and nail puller, this traditional tool is one of the most simple and effective nail removers that you can own. Various models are available, ranging from the combination type shown that has both a right-angle and slightly angled head, to those that combine a prying, chisel-type wrecking bar head along with the standard claw. To use the cat's paw, you simply drive the claw end in under the nail-head, and then lever the nail out. Expect to pay from \$5 to \$15 for a cat's paw depending on size.



CHALKLINE

A straight line is still the shortest distance between two points. And when you need a straight line, one of the most foolproof and direct ways to achieve it is to simply stretch a string. Chalklines handle this job, and go one step further. This tool holds the string on a reel so it's ready when you need it, and also embeds the string with colored chalk. Snapping the taut string on a long board marks a straight line for cutting or planing reference. Chalklines generally cost under \$10.



CHIP CARVING KNIFE



Chip carvings are typically low-relief carvings, usually of a geometric nature. Much of the work is based on simple triangular and curved cuts that remove chips of wood. These can be repeated in hundreds of combinations to produce designs of extraordinary complexity. The basic tools for making the cuts are called chip carving knives. The knives come in a variety of shapes, each designed to facilitate a certain cut or operation. Some knives are sharpened on one edge only, while others may be sharpened on two or three edges so that they can be used in both forward and reverse directions. Expect to pay \$40 or more for a set of 10 chip carving knives.

CHISEL

Although the chisel can take many forms, the most familiar version is the standard, bevel-edged carpenter's chisel. It takes its name from the sloping edges on the top face of the blade. The cutting edge is formed by a bevel that's ground on the upper face of the tool, and the back is ground perfectly flat. Most bevel-edged chisels have a handle that's pressed over the chisel tang. A ferrule around the handle where it meets the chisel blade rein-



forces the wood. Socket chisels, usually larger and subject to more abuse, have a deep tapered socket at the end of the blade in which the handle fits. Chisels designed to be struck with a mallet usually have a hoop at the top of the handle, or may have a tang that carries through to a metal cap at the top of the handle. A large relative of the chisel is called a slick. This tool is never struck, but rather used for hand paring broad surfaces. Chisels are available in different quality ranges and prices, with an average set of five costing about \$40.

CIRCULAR PLANE



Traditional carriage makers, wheelwrights and coopers often needed to plane circular components, so they developed specialized wooden planes for these jobs. However, a dedicated plane was needed for each size arc. This all-metal plane features a flexible sole that is adjustable for handling a large range of both convex and concave arcs. The base is bent to the desired shape by a vertical adjusting screw that goes through the center of the plane. The tool has the same blade-adjustment mechanism that's found on bench planes and costs about \$150.

CIRCULAR SAW, PORTABLE

The portable electric circular saw is standard equipment for cutting lumber quickly and with moderate accuracy. Although primarily a construction tool, it's frequently used in the shop, in conjunction with cutting guides, and can be installed upside down in a table for an economical table saw. Many shops keep them on hand for rough-cutting long stock and panels to size. Saw sizes are designated by maximum blade diameter, and range from about 4½ in. to 16 in., with the most common being 7¼ in. The saw base tilts to 45° for handling miters and bevels, and the blade depth can be adjusted either by a pivoting or drop-foot base. A 7¼-in. circular saw can cost as little as \$30 or as much as \$300.



CIRCULAR SAW BLADE



These days, most shop people have switched from steel to carbide-tipped blades because of the carbide's long-wearing characteristics. And, if you work with plywood or particleboard, they're almost a necessity. However, carbide blades *do* get dull. And while you can touch up carbide with a diamond hone, you'll need to send the blade out for a proper sharpening job. The beauty of a steel blade is that you can do the job yourself with a few simple tools. And, some pros maintain that a carbide blade will never be as sharp as a steel blade. Both types are offered in three basic designs: rip blades, with square tooth tops; crosscut blades, with the teeth ground in alternate bevels; and combination blades, which are similar to crosscut blades but usually have raker teeth to help when ripping. In general, the more teeth, the finer the cut with a loss of cutting speed. Triple-chip carbide blades alternate a flat-ground tooth with a tooth that has beveled corners and are useful for manufactured panels. Other variations include those with negative-rake teeth that stand up to nail impact, Teflon-coated blades for reduced friction, fishhook tooth blades and rate-of-feed limiting designs. The blades shown are (from top to bottom): steel combination, steel crosscut, steel planer (taper ground with no tooth set), carbide rip and carbide crosscut. A 10-in. carbide combination blade costs about \$55. A comparable steel blade may cost under \$20.

COMBINATION DRILL BIT

To install screws that are to be plugged or countersunk, you'd usually use three separate bits—unless you use this tool. It has a tapered twist drill that bores the proper pilot hole for standard wood screws. Secured by two setscrews is the counterbore for cutting the plug hole or countersinking the screwhead. Stop collars are available to limit the depth of the counterbore. A set of seven bits with appropriate counterbores and stop collars costs about \$60.



COMBINATION MACHINE



Just about every stationary power tool uses a motor, switch, arbor, table and base. Not only are you duplicating equipment when you own dedicated machines, but when you're using one, the others are just taking up space—and your hard-earned money. Combination machines are designed to use the same basic components to perform several different machining operations. They're usually less expensive than equal-quality separate machines, and they often have a few features that many small shops would never buy a single machine for. One of the most popular combination machines is the Shopsmith Mark V (top photo). With a few quick adjustments, this tool changes from table



saw to drill press, lathe, disc sander and horizontal drill press. In addition, the motor, with its infinitely variable-speed control, can be used to power accessories such as a jointer, band saw, planer, jigsaw and others. Basic Shopsmith combination machines range in price from about \$1600 to \$1900. In Europe, a different kind of combination machine is manufactured that's gaining in popularity on this side of the Atlantic. One example is the Robland X31 (photo above). This machine combines the functions of a 10-in. table saw with sliding table, mortiser, shaper, and 12³/₁₆-in. jointer and thickness planer. It suits the serious amateur and professional by handling all of the typical cutting and milling operations. Three 3-horsepower motors supply power to this combination machine, which costs about \$5250.

COMBINATION PLANE



Before shapers, routers and molding machines, woodworkers relied on hand planes with profiled cutters and matching bodies to get the job done. One of the last survivors of the molding plane era is the combination plane. The most widely accepted version was offered by Stanley as the No. 45 combination plane, and a reproduction of this design is still manufactured in England. Capable of handling a range of profiles, including beading, sash molding, tongue-and-groove, ovolo and slotting, the tool, with all of its accessories, sells for about \$575. Simpler versions of this plane are available for as little as \$90.

COMBINATION SQUARE



The steel combination square has a head that slides along the blade and can be locked at any position. One side of the head is at 90° to the blade, and the other side is at 45°. In addition to checking and laying out right angles and miters, the tool can be used as a depth gauge and ruler. Most models have a level mounted in the head and a removable scriber for marking lines. They range in price from \$15 to \$50.

COPING SAW

Coping is the practice of joining molding, or any other contoured work, so that one piece is cut to fit around the profile of the other piece. The tool for this job, and any others that require tight-curve cutting in light stock, is the coping saw. It has a narrow blade that's held in a steel frame via mounting pins at the blade ends. The blade is tensioned by turning the handle and can be rotated to move the frame out of line with the cut. Coping saws generally cost less than \$10.





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CORDLESS TOOL

Virtually an unknown field several years ago, rechargeable, battery-powered tools are now well established in most homes and workshops. The cordless drill and screwdriver are the most common, but manufacturers also offer circular saws, sabre saws, sanders, laminate trimmers, grinders and even glue guns. The heart of the cordless tool is the nickel-cadmium battery. These are usually 1.2-volt cells added in series to achieve the desired voltage. The more powerful wood



working tools, other than screwdrivers, have removable battery packs so one pack can be in the charger while another is in the tool, and a power range from 7.2 to 12 volts. Charge time for the tools is usually an hour with some requiring only 15 minutes to recycle a battery pack. Several makers offer a system where one battery and charger can service a variety of tools.

CORNER CHISEL

With a precise right-angle cutting edge and inside bevels, this tool is capable of cutting clean, square corners in mortises. It's commonly available in 3/8- and 1-in. sizes. A 1-in. socket version is especially suited for heavy-timber frame construction. Prices range from \$35 to \$75.

**COUNTERSINK**

Unlike roundhead screws, flat-head and oval-head screws are designed to sit either fully or partially below the surface of the work. To do the job neatly, you need a countersink. This tool can be used with either a hand or power drill and finishes the pilot hole with an 82° conical hole to match the screwhead. The traditional design has six evenly spaced cutting edges. Newer designs of the countersink reduce chatter and produce a cleaner hole by varying the design or spacing of the cutting edges. A countersink can cost anywhere from \$7 to \$20.

**CRANKED-NECK CHISEL**

Paring the bottom of a groove or dado can be difficult with a standard chisel because the inline handle eventually gets in the way. The offset handle on a cranked-neck chisel allows it to be used flat against the stock at any place on the work surface. The design does sacrifice strength, however, and these tools should not be struck with a mallet. Available in widths ranging from 1/4 to 1 1/4 in., the chisels are sold for about \$20 to \$60 each. Smaller versions are available for carving.

**D****DADO BLADE**

A dado is a flat-bottomed, crossgrain slot that's often used as a housing in shelf and cabinet construction. And, if you own a radial-arm or table saw, the fastest way to make this joint is with a dado blade. Not confined to simple dados, this blade is also useful for cutting grooves with the grain, rabbets, lap joints, tenons and bridle joints. The dado blade is a circular saw blade that cuts an extra-wide kerf. The traditional type (shown above) is comprised of two ordinary looking blades with chipper blades sandwiched in between. The chippers can be added or removed to alter the dado thickness in a series of fixed steps. The width range of most units is from 1/8 to 1 3/16 in. Steel dado sets start at about \$30, and carbide-tipped versions can run as high as \$300. Wobble dado blades (shown top right) are usually 1/4-in.-thick carbide-tipped blades that can be adjusted away from 90° to the saw arbor. This creates a wobbling effect when the blade is spinning, and also produces a kerf that's wider than the width of the blade. By adjusting the amount of wobble, any groove width



between 1/4 and 13/16 in. can be cut. New twin-blade wobble dado blades produce a flatter-bottomed cut than the standard single-blade version, and wobble discs are available for turning any circular saw blade into a narrow-range dado blade. Standard carbide-tipped wobble dado blades start at about \$40.

**DISC SANDER, PORTABLE**

The right-angle disc sander is not for the small, dedicated cabinet shop. However, if you're involved in heavy-duty surface work, boatbuilding, boat maintenance or large sculpture or carvings, this may be the tool for you. In addition to standard abrasive discs, it can be fitted with pads for polishing and buffing. For very light-duty occasional work, disc sanding attachments are available for electric drills. Consumer models start at about \$50, and pro units can cost \$200.

DOVETAIL JIG

If you're hesitant about cutting dovetails by hand, or you'd simply like to let a machine do the work, all you need is a router, a couple of special bits and a dovetail jig. The most common and inexpensive jig is comprised of a template that has guide fingers a fixed distance apart. When the wood is clamped in the jig, the router and dovetail bit follow the finger template to cut one half of the joint. The mating piece is then clamped in position to make the second half of the dovetail joint. More expensive jigs, such as the one shown, allow complete flexibility in dovetail spacing and layout. This type requires two different bits—a straight bit for cutting the pins and a dovetail bit for cutting the tails. Dovetail jigs range in price from about \$30 to more than \$200.

DOVETAIL SAW

For the accurate sawing required in delicate work and fine, carefully fitted joinery, the normal backsaw is often too large and unwieldy. Dovetail saws have the same basic features, but on a smaller scale. They also have a handle that's more like a chisel or file handle—in line with the tool and suited to control rather than power. Typical blade length is around 10 in., and 15 to 21 tpi (teeth per inch) is common. Some special models have interchangeable blades. For sawing in confined spaces or when the handle is in the way, offset-handle saws are available. The saws range from \$5 to \$20.

DOWEL CENTERS

Doweling is a fast and effective way to join wood, but its success depends on accurate hole alignment. Dowel centers are by far the simplest and most inexpensive way to get the job done. To use a dowel center, bore the dowel hole in one mating surface, and then insert the dowel center. When you press the components together, the point on the dowel center accurately registers the hole position on the second piece. Dowel centers are available for holes $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. in diameter. A set of all three sizes costs about \$4.

DOWEL FORMER

To work properly in a joint, a dowel must be just the right size and have grooves that permit the excess glue to escape. This tool has hardened steel dies through which you drive a slightly oversized pin. The excess wood is sheared away, and glue grooves are formed. The model shown has a chamfering feature for shaping the dowel ends. It costs about \$15.

DOWELING JIG

The surest way to proper dowel-joint alignment in the widest variety of situations is with a doweling jig. These are available in several designs with prices ranging from \$25 to \$150. While some types are better than others at certain kinds of joints, they all operate on the same principle. Each has guide holes corresponding to the common dowel sizes for guiding the drill bit, and a clamping system to register the hole locations. The doweling jig shown centers holes for edge gluing.

**DRAWKNIFE**

A drawknife is the traditional tool for shaping stock along the grain. The blade is straight or slightly curved and ranges in length from 5 to 13 in. It has a bevel on one side similar to a chisel. On some older models, the handles are independently adjustable so the angle can be changed to suit the work. Drawknives generally cost between \$20 and \$40. While the drawknife is always pulled, a variation called the pushknife is designed to be pulled or pushed. This tool has handles that are in line with the blade.

DRILL GUIDE

With a drill guide, your portable electric drill can rival the versatility of a drill press. This accessory can be fitted to most $\frac{1}{4}$ - and $\frac{3}{8}$ -in. drills. Its primary function is to hold the drill so the bit remains at a consistent angle to the work. While some models are fixed at 90°, the unit shown handles angles from 45° to 90°. A V-notch in the base holds round stock for accurate, centered holes, and an adjustable depth stop is provided. When used with a sanding drum in the drill, the guide can be mounted upside down on a table for stationary sanding. Drill guides range from about \$25 to \$40.

**DRILL PRESS**

Here's one stationary tool that few shops would want to do without. With it, you can bore holes accurately and consistently in a wide variety of materials. The typical design features a rigid support column on top of which is mounted the motor and drilling head assembly. Power is transmitted through a belt and pulley system that facilitates changing speeds. A sturdy column-mounted table is adjustable in height and angle. A variation on the standard machine is the radial drill press. Here the drill head is mounted on a cylindrical arm so that the head can be pivoted to change the drilling angle. Drill press sizes are designated by the distance, from the chuck to the support column (throat capacity) and range from about 20 in. for large floor models, to 8 or 10 in. for a bench-type machine. Heavy-duty $\frac{1}{2}$ - or $\frac{3}{4}$ -in. chucks are standard, and some machines feature as many as 16 speeds. In addition to boring holes, drill presses are capable of light-duty milling with appropriate accessories. Drum sanders allow accurate edge sanding, and mortising attachments bore square holes. The 10-in. bench model shown costs about \$180.

**DRUM SANDER**

These accessories are used for contouring and edge sanding, and are designed to be used in drill presses and portable power drills. The most common type features a rubber drum on which a sanding sleeve is fitted. Tightening the nut on the drum arbor expands the rubber to lock the sleeve in place. A typical set of four drums ranging from $\frac{1}{2}$ to 1½ in. in diameter costs about \$12. Other models are available that use ordinary sandpaper. For carefully smoothing contoured objects, inflatable sanding drums are available for about \$60. The standard type is about 2 in. in diameter, 8 in. long and mounts between lathe centers. A model is also available for drill presses.



DUST COLLECTOR

Woodworkers who don't have a problem with sawdust and shavings either never build anything or own one of these—a dust collector. Considered a necessity in large shops, the dust collector is quickly becoming a common fixture even in the basement workshop. A medium-sized model, like the one shown, can be connected to various power tools with a 4-in.-dia. hose. The upper bag filters the dust-laden air, while the lower bag collects the waste. This model's 11½-gallon capacity is ample for saws and small jointers, but if you're running your 12-in. thickness planer much, you might need a larger dust collector. Smaller models are also available. This 1-horsepower unit costs \$300.



E

EDGE BANDER



Using plywood and other manufactured panels is great until you have to deal with the edges. Manufacturers and professional shops solve the problem with edge-banding machines that cost more than the average family car. If you're looking for a less expensive alternative, you might try one of the small edge banders on the market. The Freud unit shown is a benchtop machine that uses banding material with a backing of thermoplastic glue. As the panel is fed across the machine, a heat gun softens the glue to adhere the banding to the edge. This

particular model costs about \$300, and 200 ft. of 13/16-in.-wide prepared wood banding runs about \$45. Also available is a handheld edge-banding machine from Viturex for about the same price.

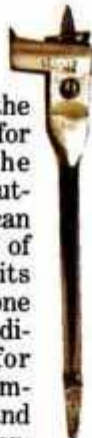
EDGE CLAMP

Most clamps work by applying pressure from the opposite faces or edges. When you're simply clamping a piece of trim to a wide panel, the standard clamps are often unnecessarily large. This edge clamp grips the faces much like a normal clamp, so that the central, perpendicular screw can bear against the panel edge. Both of the face-gripping screws can be adjusted to accurately position the edge screw over the edge. These clamps come in several sizes and designs—a small 2½-in. model costs about \$6.



EXPANSION BIT

Also called an expansive bit, this tool is an adjustable auger designed to be used in a brace. It features the typical lead screw at the tip for drawing the bit through the wood. However, the actual cutter is a separate blade that can be positioned to suit the size of the hole required. These bits generally come in two sizes: one for holes from ⅝ to 1¼ in. in diameter, and a larger size for holes from ⅞ to 3 in. The simplest type has a single screw and clamping bar to hold the cutter. Other models feature a dial mechanism for setting and securing the cutter. Expect to pay about \$14 for a basic expansion bit.



F

FAST-ACTING CLAMP

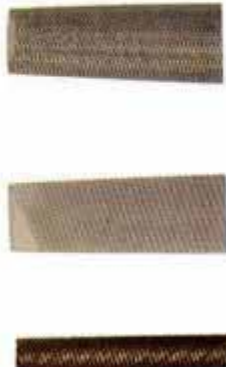
These clamps are standard in nearly every shop. They operate through the locking or jamming of the lower jaw on the bar as the



clamp is tightened. They're available in light- and heavy-duty models with enough clamping power for all typical woodworking jobs. A small, 6-in. bar-length clamp with a throat depth of 2½ in. costs about \$8. A heavy-duty 36-in.-long clamp with a 5-in. throat can cost about \$40.

FILE

Files are classified by shape, cut and length. The shape of a file relates to its use. For example, triangular files handle saw sharpening, and round files shape concave surfaces and holes. Some files have safe, or uncut, edges while others have cut edges for working in corners. In order of increasing coarseness, most files are graded as either smooth, second cut or bastard cut. And the longer the file, the coarser it will be. Mill files have single rows of parallel, diagonal teeth and are best for fine work. For faster cutting, double-cut files have two opposing rows of diagonal teeth. A useful woodworking file is a half-round, double-cut bastard file. Most of these files cost less than \$10.



FLEXIBLE DRIVE TOOL



While a flexible-drive accessory is available for virtually any rotary tool with a chuck, a dedicated machine, such as the one shown, is the choice of professionals for fine carving and other delicate detail work. It's designed to accept rotary files and rasps, burrs, small wire brushes, grinding wheels and sanding drums. The long flexible shaft permits reaching normally inaccessible areas and allows one-handed operation. Many tools feature infinitely variable speed up to about 14,000 rpm. Typical models range from about \$80 to \$200.



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FOLDING RULE

Before the tape measure, the folding rule was the way to carry several feet of ruler in your back pocket.

The traditional carpenter's folding rule (above) opens by pivoting the sections at their end joints. Its usual size is either 6 or 8 ft. The better models feature a 6-in. brass slide to aid in taking inside dimensions and cost about \$30. The standard 4-fold rule comes in models that open to 2 or 3 ft. Some models feature a protractor at the joint for measuring angles and have an incorporated level. These sell for about \$30.



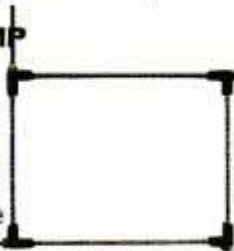
FORSTNER BIT

These boring tools are unique in that they're not guided solely by a center point. Although they do have a brad-type point, the edges around the rim of the Forstner bit are sharpened and stand slightly ahead of the radial cutting edge. This guarantees that the bit stays on track—even when boring partial holes where the center point misses the wood. It also makes for easy angle boring, pocket holes and flat-bottomed holes. Forstner bits are available in sizes that range from 1/4 to 2 1/2 in. in diameter. A set of 15 different bit sizes costs approximately \$320. A 1-in. Forstner bit costs about \$15.



FRAME CLAMP

Gluing up a mitered frame is almost fool-proof when you have the right clamp. This frame clamp has four right-angle corner blocks that bear on the work. The blocks are joined by threaded rods, and most models have quick-release nuts for rapidly setting the clamp to the correct size. A standard frame clamp will handle work from 2- to 17 1/2-in. square and costs about \$20. Extension sets for larger frames are available.



FRAMING SQUARE

Also called a steel square (although it may be made of brass or aluminum), this is the tool that carpenters use to lay out and check right angles. It's also handy in the workshop as a large-square, straight-

edge and rule. The standard size has one leg at 24 in. and the other at 16 in. This tool is particularly useful in handling the right-angle geometry required in roof framing. Some models, usually called rafter squares, have tables marked on the sides that assist in calculating rafter lengths and angles. These often have divisions in 12ths, as well as 16ths, so that scaled conversions from feet to inches are simplified. A good framing square should cost less than \$20.

FRET SAW

Although this looks like a coping saw, it differs in its extra-deep throat that permits working well away from a panel edge. It also has blade clamps for securing the blade—coping saws use a blade-pin securing system. This type of saw costs about \$12. A variation of the fret saw is the piercing saw, or adjustable fret saw. This has a shallow-throat frame that's adjustable for different length blades. With this feature, broken but otherwise sharp blades can be reused by simply adjusting the frame length to suit the blade. Fret-saw blades are available for cutting a wide range of materials.



G

GIMLET

If you need one or two small holes, it doesn't pay to pick up a drill—use a gimlet instead. These small augers have a lead screw that pulls the tool through the wood, and flutes that clear the chips. A set of seven (\$7) handles pilot holes for No. 2 through No. 9 screws.



GLUE GUN

When you need fast, strong adhesion, the glue gun is often the only tool. Using thermoplastic glue in stick form, the standard glue gun has an electrically heated nozzle that liquefies the glue as it's pushed through. The better models are trigger-fed rather than fed by thumb pressure. Cordless models are available including one that operates via a gas cartridge rather than electric battery power. A typical glue gun will cost from \$15 to \$30, with professional models going for about \$85.



GOUGE

A gouge is a straight, chisel-type tool with a curved cross section. The most common type has the bevel on the outside of the curve and is called an out-cannel gouge. It's used for shaping concave surfaces. An in-cannel gouge has the bevel on the inside, and is particularly useful in trimming coped joints such as door and window frame moldings. A 1-in.-gouge costs about \$18.



H

HAMMER

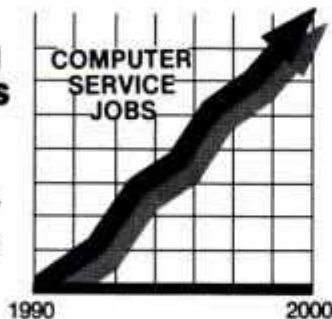
The usual shop hammer has a curved claw for effective nail pulling. Straight claw, ripping hammers are more often used in rough carpentry. Quality hammers can have wood or fiberglass handles, or feature 1-piece steel construction. Weights range from 10 to 24 ounces, with prices running from \$10 to \$30. Another useful hammer is the cross-peen or Warrington hammer (right). The narrow head helps in driving small brads held between your fingers. Warrington hammers are available in four sizes ranging from 3 1/2 to 12 ounces.



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HAND DRILL

This egg beater-type drill is a realistic alternative to power drills. Its 5/16-in. chuck handles standard twist-drill bits. The particular model shown has a breast drilling attachment in place for using body pressure to help the work. For normal drilling, the round wooden side handle replaces the breast drilling attachment. It's ideally suited for small holes where extra power isn't needed. This model costs about \$40.



HANDSAW

Today, the most common handsaw is the crosscut saw. And, when sharp, it's still a fast and effective way to cut wood. Standard lengths are 22 and 26 in. long, with short 15-in. toolbox models becoming popular. Coarseness is measured by teeth per inch with 8, 10 or 12 tpi available. Although power saws have virtually eliminated the hand rip saw from most shops, it's still available—and reliable. At 5 1/2 tpi or less, these saws are very coarse and have a vertical tooth face that's more effective for cutting along the grain. Quality handsaws are taper ground (progressively thinner away from the teeth) to reduce binding. You can pick up an inexpensive crosscut saw for about \$15, while the better tools cost around \$50. Western-style saws are now available with a fast-cutting Japanese tooth design.



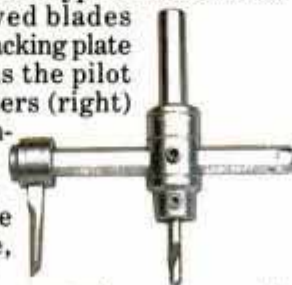
HAND SCREW CLAMP

These clamps have a large bearing surface, can clamp nonparallel surfaces, are relatively nonmarring and are fast to operate. They're commonly available in six sizes, ranging from a small 6-in. jaw, 3-in. maximum-opening model, to a 16-in. jaw-length clamp that opens to 12 in. The average price for a hand screw clamp is approximately \$20. Hand screw clamp kits are also available.



HOLE CUTTER

A holesaw is a cylindrical saw blade that's used with a pilot bit that centers and guides the cut. The usual type features bell-shaped cutters (right). The blade and pilot bit are mounted on a mandrel that fits in the drill chuck. Cutters are available in sizes ranging from 3/4 to 4 1/4 in. in diameter. Prices vary with quality, and a typical 5-size set costs about \$35. For heavy-duty use, bimetal blades are available. A slightly different type of holesaw has a set of curved blades that fit in a backing plate that contains the pilot bit. Fly cutters (right) also use a central pilot, but cut the circumference with a single, adjustable cutting bit mounted on an arm. A typical unit cuts holes up to 6 in. in diameter, and can only be used in a drill press. Fly cutters sell for about \$20.



HONING GUIDE

If you have trouble holding your chisels and plane irons at the correct angle when honing, you'll benefit from a honing guide. The type shown (about \$18) has a roller that rides on the bench behind the stone. Other smaller types ride completely on the stone. All types feature a locking mechanism for holding the blade and are adjustable for different honing angles.



HONING STONE

Not too long ago, the only honing stones found in most wood shops in North America were oilstones, so called because oil is used to carry away steel particles and keep the surface clean. These were either the man-made India combination stones, one side fine and the other coarse, or the three grades of natural Arkansas stones—soft, hard



and hard black Arkansas (finest). Today, many woodworkers prefer water stones. These cut faster than oilstones, but they wear quickly and must be dressed, or flattened, often. They are graded by grit size with 1000 being a general-use stone and 6000 for polishing. Diamond stones utilize diamond particles embedded in steel plates. They cut very quickly with water or oil lubrication and almost never wear out. Diamond stones aren't available as fine as oil- or water stones. A typical combination oilstone costs about \$15.

I

INSHAVE

This traditional tool is designed for the specialized job of shaping hollows. It is particularly useful in contouring the hollow usually found in traditional chair seats. The blade length is about 8 in., and the tool costs about \$30. A smaller 1-handled version called a scorp has a circular, ring-shaped blade and is useful for tighter contours.



J

JAPANESE CHISEL

The Japanese chisel has several unique features that distinguish it from its Western counterpart. It has a laminated blade with a very hard, high-carbon steel bottom layer that takes a razor-sharp edge and holds it well under use. The top layer is a less-brittle, tough steel for blade strength and durability. The bottom of the blade is hollowed or relieved in the center to make lapping easy and reduce friction in use. In addition to the standard bevel-edge chisel design, Japanese chisels are available as mortise chisels, corner chisels and dovetail chisels. Offered in a range of sizes, an 18mm bevel-edge chisel can cost about \$35.



JAPANESE PLANE

The big difference in Japanese planes is that they're meant to be pulled, not pushed, and therefore must be razor sharp to be effective. Like Japanese chisels, they use a laminated-steel blade that combines hardness and durability. The blade is very thick to prevent chatter. The wooden body is generally made of Japanese red oak, and several sizes are available. A roughly 10-in.-long plane with a 2-in.-wide cutter costs about \$100.

JAPANESE SAW

Because Western saws cut on the push stroke, they must be relatively heavy to resist bending or buckling under sawing pressure. Japanese saws, on the other hand, cut on the pull stroke. This puts the blade in tension so it stays straight and can't bend. The blade can then be made thinner, which means a narrower kerf and less effort required. The standard saw is called a dozuki, or tenon-shoulder, saw. Like a backsaw, however, it's useful for a variety of different jobs. Dozuki saws range in price from \$30 to \$140. Ryoba saws are wider and usually have cutting teeth on both edges—one side is used for ripping and the other side is used for crosscutting.

JIGSAW

This stationary tool is sometimes called a scroll saw because it's useful in cutting the tight, fine curves featured in scrollwork. It's also a great general-purpose saw for the hobbyist and a good introduction to power tools for the beginner. It features a reciprocating blade that's held at both ends, and different blades are available for

wood, metal and plastic. Most types today feature a parallel-arm system that powers the blade on both the up- and downstroke, and the table tilts for handling beveled cuts. Single-speed models run at about 1600 strokes per minute, with variable-speed machines offering greater utility in different materials. A light-duty, 16-in. (throat depth), variable-speed model can cost about \$170.

JOINTER

Jointing is the process of making an edge or surface straight and flat, and this is the jointer's main function. The size of the jointer refers to the length of the cutterhead. While 4-in. jointers are available, 6- or 8-in. models are more practical. The rotating cutterhead usually holds three knives. The jointer table has a separate infeed and outfeed side. The infeed table height is adjusted to set the depth of cut. The outfeed table remains at the exact height of the cutting knives. Jointers with long tables are better suited to accurate straightening. While a jointer can plane a surface, it's not capable of accurate thicknessing. Most models have a rabbeting ledge for shaping rabbets. A small 4-in. unit can cost about \$140, while a professional 8-in. machine costs about \$1500.

K**KEYHOLE SAW**

Also called a compass saw, this tool is invaluable for making fast, curved cuts in thin wood, wallboard and other panel material. Its narrow-tapered blade fits into a small hole for making internal cutouts. Some accept several types of blades and cost \$10.

**L****LAMINATE TRIMMER**

This small router gets its name from its use in flush trimming the edges of plastic laminate. It's equipped with an edge-trimming guide and does the job with an ordinary, straight carbide bit. Some have a tilting base for bevel trimming without switching to a beveling bit. Laminate trimmers also handle other light-duty routing jobs such as rabbeting, grooving and edge shaping. They take standard 1/4-in. bits and cost from \$100 to \$200.

LATHE

Most woodworking machines have a rotating cutter that shapes or cuts the wood. The lathe reverses this situation with a cutter that stays in roughly the same place, while the work spins. The process, called turning, produces circular forms of nearly any cross section. Lathes have a headstock that contains a motor-driven center that turns the wood. At the other end of the lathe bed is the tailstock and a second center for supporting the opposite end of the work. The drive center can be replaced by a faceplate to which a block can be screwed for bowl turning. Large chucks can also be installed. The bed of the lathe holds the headstock, tailstock and toolrest—an adjustable bracket that supports the handheld lathe cutting tool. The size of a lathe is defined as the distance from the center to the bed. Maximum length is the distance between the two centers. Light-weight hobby lathes start at about \$150, with full-featured models costing more than \$1000.

M

MALLET

Mallets are striking tools—similar to hammers but lighter and used for operations requiring a lot less force. The standard round carver's mallet (right) is used for driving chisels and gouges, and is usually made of a dense hardwood for durability. Carpenter's mallets generally have rectangular heads with angled striking faces and separate handles. Plastic mallets (left) are handy for tapping joints together and aligning components without marring surfaces. Dead-blow mallets feature heads filled with metal shot for generating maximum force with little rebound. Woodworking mallets cost from \$10 to \$30.

MARKING GAUGE

This tool is used to scribe a line parallel to the stock edge. More sophisticated marking gauges have two scribing pins for marking both sides of a mortise or tenon at one time. Most models have brass rubbing strips on the stock to reduce wear. Marking gauges that have knife-type scribing pins work across the grain, whereas the pin-type scribers work better with the grain. These tools cost about \$10 to \$60.

MITERBOX, HAND



This tool is used to crosscut trim, molding, picture frames and other



components to be joined. The simplest miterbox is a wooden jig that holds a saw blade at a consistent angle to the work so repeated cuts can be made with accuracy. Full-featured metal miterboxes use backsaws from 18 to 30 in. long. The saw can be set at any angle from 45° to the right or left, and there are positive locks at the most commonly used angles. Some models use a saw with a lightweight replaceable blade that's tensioned in a special saw frame to keep it straight. Miterboxes cost from \$25 to more than \$300.

MITERBOX, POWER



Power miterboxes, sometimes called chop saws, are increasingly popular in both the construction trades and workshops. Capable of great accuracy, these tools are unsurpassed for speed and convenience for cutting wood to length at any angle. While smaller models are available, the most common unit size uses a 10-in. blade. Capacities vary, but 90° cuts on 2 × 6 stock are common, and 4 × 4s can be cut to length in one pass. More sophisticated machines also have an adjustable bevel angle for cutting compound miters. Ten-in. saws cost between \$200 and \$300. A variation on this theme is the sliding compound-miter saw. This tool increases cutting capacity with the motor unit mounted on a sliding carriage.

MITER SQUARE



Next to the right angle, the 45° miter is the most common cut in the shop. To lay it out and check it correctly, you need a dedicated tool just like your try square. This tool features a blade that extends past the stock so that both 45° and 135° can be measured. The model shown costs about \$50.

MITER VISE



This vise securely holds two adjacent sides of a mitered frame for nailing and gluing. It handles stock up to 4 in. wide and has a groove so you can precisely trim the clamped stock with a backsaw. Designed to be permanently secured to a workbench, this vise swivels and tilts. It costs about \$160. A smaller, light-duty version, called a corner clamp, also has a fine-trimming saw groove and costs less than \$10.

MOISTURE METER

All woodworkers know that the moisture content of wood must be in balance with the humidity of the environment—or the wood will move with frustrating and often disastrous results. And, buying kiln-dried wood is no guarantee that you're buying adequately seasoned stock. The only way to know for sure is to measure the moisture content yourself. The best tool for this job is a moisture meter. These tools measure the water in wood by gauging the resistance of the material to a small electrical current. The sharp probes at the top of the unit are pressed into the wood at various locations to make the measurement. The moisture meter shown indicates 10 ranges of percentage moisture content, from 0 to 20 percent, and costs about \$100.



MOLDING HEAD

If you have a table or radial-arm saw, you don't necessarily need a shaper or heavy-duty router to make your own molding, you can simply use a molding head instead. This 7-in.-dia., 3-cutter model fits a standard 5/8-in. arbor, and costs about \$20 without cutters. Dozens of cutter profiles are available for making standard trim, picture frame stock, raised panels and other millwork. Complex moldings can be made by shaping portions of the stock with different cutters. Cutters cost about \$7 for a set of three.



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MORTISE BIT, DRILL PRESS

You can bore a square hole with a drill press—if you use one of these composite mortising bits. It's comprised of a special auger that's housed inside a square chisel. As the auger removes most of the waste, the chisel corners trim the hole square. By clamping a fence to your drill press table, you can bore a series of adjacent square holes to produce a rectangular mortise. Available in standard 1/4-, 3/8- and 1/2-in. sizes, these bits require a special accessory designed to fit your drill press. A typical mortising bit with appropriate square chisel can cost approximately \$30.



MORTISE CHISEL



Cutting mortises by hand is heavy work. For a chisel that really stands up to pounding and levering, use a mortise chisel. The blades have a heavy, rectangular cross section with square, parallel sides that help in cutting square-cornered mortises. The extra heft stands up to prying and levering out the mortise waste. Most types have a hoop at the top of the handle to withstand mallet work, and a leather washer between the blade shoulder and handle to help absorb shock. Available in widths between 1/4 and 5/8 in., a 1/2-in. mortise chisel can cost around \$20. Mortise chisels are also available in the Japanese style.

MORTISE PLANE



Also called a butt mortise plane, this tool is used for cutting the shallow mortises required for door hinges, strike plates and other flush-set hardware. And for handling small jobs, it can be faster than using a machine. To use it, the walls of the recess are first delineated with a chisel. Then, the plane shaves away waste in a series of steps where the cutter depth is increased until the correct mortise depth is reached. A large opening in front of the blade improves visibility. The mortise plane costs about \$40.

MULTI-SPUR BIT

Like the Forstner bits, multi-spur bits excel at boring angled and overlapping holes. The toothlike rim cuts quickly while radial cutters remove the waste. It produces smooth, clean holes and has a center point for centering the bit. The bit is available in different sizes from 3/8 to 1 1/2 in. in diameter, and a 1-in.-dia. multi-spur bit costs about \$20.



N

NAILSET

This punch is designed for driving nails slightly below the surface so that the nailhead can be covered before finishing. They're offered in tip diameters of 1/32 to 3/16 in., and have slightly concave tips for gripping the nail. A set of four can cost around \$7. Also available are L-shaped, offset nailsets that allow you to keep your fingers out of the way. These come with two sizes of tips and cost about \$5.



O

ORBITAL SANDER

These small finishing sanders do their job by rotating ordinary sandpaper in very tiny (about 1/16-in.-dia.) orbits, at speeds of around 14,000 orbits per minute. This makes for a fine finish with little or no evidence of scratching. The most common type is a 1/4-sheet sander (about \$50), but 1/2- and 3/4-sheet models are available for making fast work of large surfaces. Some units come equipped with dust bags, and stick-on, adhesive-backed sandpaper is an option with some makes. Newly developed electric random-orbit sanders offer improved swirl-free performance, and take less time to get the work done.



P

PANEL SAW



If you cut a lot of plywood or other panel stock, you know how cumbersome a job it can be. That's why panel saws were invented. This tool is comprised of a vertical frame on which a track that carries a circular saw is mounted. The panel to be cut is positioned on a ledge at the bottom of the frame, and the saw is drawn down to make the cut. Typical panel saws handle standard stock sizes and the saw can be pivoted to accommodate ripping along the panel length. Prices range from about \$800 to \$1000.

PIN ROUTER



A pin router is an overarm router that's designed to make use of templates for repetitive routing jobs. Directly under the router bit is a pin protruding above the table surface. A template with the cutout routing pattern is secured to the bottom of the workpiece and placed over the pin. With the bit lowered into the work, the stock and template are guided by the pin so the work is shaped to match the template. While professional shops use heavy-duty dedicated pin routers, accessories like the one shown make use of standard routers and handle light-duty work. Prices range up to \$1000 for a unit with pneumatically controlled router plunging.

PINCH DOG

These simple tools are like having a second pair of hands when gluing up panels. By tapping them in the ends of aligned boards, they hold the stock in place until the clamps are installed. They're available in sizes from 1 to 3½ in. wide. A pair of the 2-in.-size pinch dogs costs about \$7.

PIPE CLAMP

These economical clamps have a head and tailpiece and require ordinary black iron pipe for the bar. Most types have the screw/handle clamping head threaded at one end, while the sliding tailpiece jam-locks under pressure. Others have the screw/handle assembly in the sliding head. With this type, you can reverse the head and tailpiece for spreading apart pieces. You'll pay about \$7 to \$12 for a ¾-in.-pipe clamp set without the pipe. For lighter work, clamps are available that use ½- or ¼-in. pipe.

PLATE JOINER

More a complete joining system than a single tool, the plate joiner has revolutionized professional and amateur woodworking. The machine is a small plunge-cutting circular saw that cuts slots for wooden, football-shaped plates (also called biscuits). The plates act as splines in aligning and reinforcing joints, and come in three sizes. They're made of diagonal-grain, compressed beech, and expand in the slot when water-based glue is applied. The system is faster and simpler to use than standard techniques—including doweling. Plate joiners cost from about \$200 to \$600. Boxes of 1000 plates cost about \$30.

PLUG CUTTER

The exact opposite of typical drill bits, this accessory doesn't cut a hole, but cuts a plug to fill a hole. Smaller versions are used primarily for producing plugs to fill screw pilot-hole counterbores and cover screwheads. The advantage over dowels is that face-grain plugs can be made that match the wood being plugged. Extra-long plug cutters can produce short dowels (up to about 3 in.), and shape round tenons on the end of rails. Plug cutters range in size from ¼ to 1 in. A ½-in.-dia. short cutter costs about \$12. The extra-long type of the same diameter costs \$45.

**POWER DRILL**

Probably the first power tool that anyone buys is the portable electric drill. The size of a drill is designated by its chuck capacity. Standard sizes are ¼, ⅜ and ½ in. The most common and versatile medium-duty drill today is the ⅜-in., variable-speed, reversible unit. Variable speed allows you to use a wide range of accessories, such as buffers, sanders, holesaws, auger bits, paint stirrers, as well as the standard drill bits. And, in combination with a reversing feature, the drill becomes a fast power screwdriver. The ⅜-in. drills range from about \$20 to \$200, and for light-duty work or where there's no power supply, cordless models are available. Larger ½-in. drills may have variable speed or two fixed speeds and usually operate at a slower rpm for heavier work. Hammer drills are heavy-duty tools that transmit a rapid percussive effect to the bit for drilling through concrete and masonry with carbide-tipped masonry bits.

POWER PLANE

In principle, this powered tool is based on a traditional hand plane. In practice, it's more like using a portable jointer. Instead of a plane iron, it has a 2-blade cutterhead that rotates



at around 15,000 rpm. Depth of cut is set by adjusting the height of the front half of the base to a maximum depth of about 1/16 in. Most tools can plane stock about 3 in. wide in one pass and have rabbeting capabilities. Double-edge carbide blades on some models are reversible and have an automatic positioning feature for exact blade height. Used primarily for on-site carpentry, it's an excellent tool for trimming doors to size, planing heavy timbers and any other situation that a saw can't touch and where a hand plane isn't enough. Some models feature a fence to help hold the tool correctly when planing square edges. Power planes cost about \$130 and up.

POWER SCREWDRIVER

While most variable-speed power drills can be used to drive screws, the cordless screwdriver comes closest to a true-powered screwdriver in shape, convenience and use. It's especially handy when you have to install or remove several screws at a time. Typical models have built-in batteries, and the tool is generally kept in a trickle-charging stand so that it's always ready to use. Hex-shank screwdriving bits eliminate the need for a chuck, and new hex-shank drill bits add hole-boring versatility to the tool. A chuck accessory is available for standard bits. All the models are reversible, and some have a clutch that will automatically drive a screw to a specific torque. A lockup feature allows you to hand-tighten or loosen screws when power is inadequate. These power screwdrivers cost about \$15 to \$40.

PROFILE GAUGE

If you need to know the exact shape of a molding, turning detail or other contoured object, simply press this profile gauge up against the shape. Made of thin plastic blades that slide against each other to conform to the shape, this tool is available in 5½- and 12-in.-wide sizes. The smaller profile gauge costs about \$18. Metal versions of the profile gauge are also available at hardware stores.

R

RABBET PLANE



Rabbet planes differ from bench planes in that the blade extends across the entire width of the plane body. While this makes them ineffective at leveling broad surfaces, it's the ideal arrangement for cutting steps or ledges along the edges of boards. It has a fence to guide it at a set distance from the edge of the work, and an adjustable-depth stop to limit the depth of the cut. The version shown has a 1½-in.-wide blade and a screw-feed, blade-adjustment mechanism. For cutting rabbets across the grain, the tool has a spur mounted on the side that scores the wood in front of the blade and prevents splintering. For working in stopped rabbets, the blade can move forward in the plane body. Metal rabbet planes cost about \$60.

RADIAL-ARM SAW



The versatile radial-arm saw can crosscut, miter, bevel, rip, dado, groove and mold, as well as handle accessories such as drum sanders, buffing and grinding wheels and rotary planers. And, it will accept a chuck or collet for drilling or shaping chores. Based on that list of potential uses, it may seem like the radial-arm saw is the only power tool you'll ever need. However, what it does best, and what most woodworkers use it for, are simple crossgrain operations. If most of your work involves cutting stock to length, this is the saw to own. The most popular size for most shops features a 10-in. blade. Smaller portable versions are useful in general carpentry and roof framing. Radial-arm saws can be very accurate, but need

relatively frequent tuneups to stay that way. The best saws have cast-iron columns and arms, and the motor carriage runs on ball bearings. Some modern saws feature a digital readout that indicates blade position. Ten-in. models range in price from about \$300 to \$1500.

RASP



Unlike files, the teeth on rasps are individual points rather than linear cutting edges. This, in conjunction with a larger tooth size, gives a rasp the advantage for rapid clog-free cutting in wood. Rasps are generally either half-round or round in shape. The coarser ones are termed wood rasps. Cabinet rasps are finer and come in bastard, second cut and smooth grades similar to files. Patternmaker's rasps produce a smoother cut than standard rasps, due to a more staggered tooth pattern. Standard rasps cost from about \$8 to \$20, and Patternmaker's rasps cost about \$30 and up.

RIFFLER

Rifflers are small rasps or files, usually about 6 to 8 in. long, that have heads that are curved or shaped for fine work and delicate contouring. Most types are double ended, with one end being slightly coarser than the other. Invaluable for detail carving, a set of eight rifflers, in either file cut or rasp cut, costs about \$95.

ROUTER



This portable wood-milling machine spins rotary cutters, or bits, at speeds over 20,000 rpm. With the right bit, it's not only capable of molding chores, but handles dados and grooves, rabbets, mortises, dovetails and nearly any other conceivable wood joint. Router capacity is indicated by the maximum bit shank diame-



ter that the tool's collet can hold, and the motor's horsepower rating. Light-duty routers accept ¼-in.-dia. bits only, while the medium- to heavy-duty models have interchangeable collets for up to ½-in.-shank bits, and 2- to 3½-horsepower motors. Many larger routers feature variable speed so that the tool can be slowed down when using larger-diameter cutters. Also, high-torque models have a soft-start feature that slowly brings the motor to operating speed when the tool is turned on. Standard routers are adjustable for depth of cut, but must be leaned into the work when making blind cuts or mortises. Plunge routers, on the other hand, have motor assemblies mounted on spring-loaded columns so the bit can be plunged into the stock while the base remains flat on the work. Heavy-duty plunge router prices start at about \$200. Standard routers start at \$40.

ROUTER BIT

A router can be useless without the right bit. These small cutters usually have two cutting edges and are either high-speed steel or carbide tipped. Some special-purpose bits are solid carbide. Carbide bits are more expensive and last longer between sharpenings than high-speed steel. Although diamond hones can be used to touch up a carbide edge, most woodworkers have the bits sharpened professionally. Many bits have a pilot—either solid or ball bearing. This rides against the stock edge to act as an automatic fence. Pilotless bits require a router fence or guide to hold the router in position. Typical bits for forming joints are the straight, dovetail and rabbet bit with pilot. Straight cutters with helical flutes are also available. Molding bits include V-groove, ogee, beading, rounding-over, chamfer and corebox. Straight bits with pilots the same diameter as the bit can be used to flush trim laminates or follow templates.



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ROUTER PLANE

This traditional tool is based on an earlier wooden version often called a hag's tooth. Its purpose is to cut dados, grooves, shallow mortises and to generally level and flatten recesses. The router plane uses an L-shaped cutter whose height can be adjusted with the vertical screw and adjustment wheel. It can be used with a special fence for running grooves parallel to a straight or contoured edge. The router plane costs about \$55, and smaller versions are available for more delicate work.

ROUTER TABLE

Here's an accessory that turns a portable router into a stationary tool, or miniature shaper. The router is mounted upside down under the tabletop and the bit protrudes through the center hole. Stock can be guided past the bit with the miter gauge, or simply held against the fence. Piloted bits can be used without the fence or miter gauge. Although basic router tables are simple to make, they're commercially available and range in price from about \$30 to \$120. Table saw extensions that take advantage of the table saw fence are also available for mounting a router. Although, most routers will work in a router table, the most versatile unit is a large, high-horsepower model with variable speed. A more sophisticated router fixture features a horizontally mounted plunge router and sliding table for holding the stock. These versatile units handle a wide range of joint cutting operations and cost more than \$500 without the 2¼- to 3-horsepower plunge router required.

S

**SABRE SAW**

A portable version of the stationary jigsaw, this tool differs in that only one end of the blade is fixed. This allows it to pocket cut (cut an enclosed hole), but reduces blade stability and cutting accuracy. The sabre saw is primarily used for cutting curves in stock 1 in. thick or less. Heavy-duty models often have an orbiting-blade feature. Here, the blade moves forward and backward as it moves up and down to increase cutting speed. Some sabre saws are called scroll saws because the blade can be pivoted to follow a tightly curving outline. Sabre saws cost from \$30 to \$200.

SCRAPER

You don't always need sandpaper to produce a smooth finish. Many woodworkers rely on a scraper for this job. These steel plates are shaped with a burr or hook along the edges. When pulled or pushed across the wood, a thin shaving is produced. They come in different weights and shapes to suit the job at hand. A typical set of four scrapers costs about \$10.

SCREWDRIVER

Slot-head screwdrivers come in sizes to fit No. 0 through No. 24 slot-head screws, and blade lengths range from 1 to 24 in. Phillips-head drivers offer better gripping power and come in sizes No. 0 through No. 4. Many shops are turning to square-drive (Robertson) screws and screwdrivers for slip-free hand or power driving. Combination screwdrivers store interchangeable tips in the handle and offset drivers are L-shaped for tight areas.

**SHAPER**

Woodworkers who handle repetitive millwork, or who need to cut molding profiles of greater depth than most routers can handle, use a shaper. These stationary tools feature a vertical spindle on which a cutter is fitted. Cutters are typically 3-blade designs, and molding-head-type units are available that accept interchangeable knives. Spindle diameters of medium-duty machines are either ½, ¾ or 1 in., and some machines have interchangeable spindles to suit a range of cutters. Industrial machines have 1¼-in. spindles, and adapter bushings are available for using these larger cutters on 1-in. spindles. Most units also accept a collet that handles router bits for light-duty work. Two-speed machines run at 7000 and 10,000 rpm, and handle a wide variety of cutter diameters. For instance, cutters up to about 6 in. in diameter can be handled on a 1-in. spindle at the slow speed. Some machines feature a sliding table option for accurate and convenient repetitive work. While most shaper cutters are designed to rotate counterclockwise, many machines have a reversing switch to accommodate a special cutter or allow the cutter to be flipped over and used from the opposite direction. Moderate-size shapers use a 2- or 3-horsepower motor and cost somewhere between \$1000 and \$2000.

SHAVEHOOK

For smoothing contoured molding profiles, cleaning out tight corners, removing dried glue or stripping paint, nothing beats a shavehook. These tools come in several different head shapes to meet every situation. A set of three costs about \$12. For more versatility, choose a model with interchangeable heads that match nearly any molding profile.

SHOULDER PLANE

Whether you cut your tenons with a table saw, router or by hand with a backsaw, it's not unusual to spend a little extra time for the best possible fit. And, although the tenon may fit snugly in the mortise, the joint's outward appearance is ruined if the tenon shoulders aren't cut properly. A shoulder plane is a low-angle rabbet plane that's designed to trim end-grain tenon shoulders for a perfect fit. The plane's sides and base are accurately machined so that they're square. It has a screw-feed blade adjustment mechanism and the blade should be razor sharp and set for a fine cut for the tool to work properly. The shoulder plane is also handy for fine-trimming rabbets and other square cuts. Some models have a detachable front nose section that, when removed, converts the tool to a chisel plane that's capable of cleaning out the ends of stopped grooves and rabbets. Small bullnose versions are also available. Shoulder planes range in price from about \$50 to \$150.

SLIPSTONE

The real secret to successful woodcarving has less to do with the kinds of tools you use than the condition that they're kept in. It's crucial that they be as sharp as possible. While the final step in sharpening gouges and other carving tools is to strop the edge razor sharp, preliminary honing requires a stone that's shaped to closely match the curve of the blade. Slipstones, or simply slips, come in various shapes and grades, just like standard honing stones. Some are water stones, while the traditional variety are lubricated with honing oil. One type of combination water slipstone features rows of



concave and convex shapes formed into the top of the stone. Prices range from about \$5 to \$25, depending on the grade, material and size of the slipstone.

SLIDING BEVEL

If everything wooden was indeed made up of right angles, you probably wouldn't need this tool. Also called a sliding T-bevel or a bevel gauge, it's indispensable for copying, laying out and checking angles other than 90°. The pivoting blade can be positioned so that the supplement of the angle on one side appears on the other side. The brass-capped, rosewood model shown costs about \$13, but an inexpensive (\$5), plastic-handled version will do the same job.

SPADE BIT

These are clearly the simplest and most inexpensive bits for boring large holes. They're available in sizes ranging from ¼ to 1½ in. and can be used in a portable drill or drill press. They do require more power than auger bits and are not well suited to cordless units. The basic type with straight cutting edges is easy to sharpen and can even be custom ground to a smaller size to suit a specific application. Newer versions have spurs at the corners to cut cleaner holes, but are more difficult to resharpen. While the standard spade bit is about 6 in. long, 6- or 12-in. extensions can be added to increase versatility. Extra-long, 1-piece, 16-in. bits are available for portable electric drills only. Modified spade bits include those with lead screw tips similar to an auger, and unique round-shoulder bits for cutting curved holes. Standard spade bits cost about \$2 for a ¾-in. size.

**SPLIT POINT BIT**

To improve the efficiency at the very center of an ordinary twist drill, the split point bit has special bevels ground to meet at the point from opposite sides. This creates better cutting action at the tip and it also helps to reduce the skating effect when the hole is started. The split point bits are often coated to help reduce friction and heat buildup. The

model shown, called the Sidewinder, costs about 30 to 50 percent more than a standard twist drill bit of the same size.

SPOKESHAVE

For carefully trimming and smoothing flat surfaces, you need a plane. But, if the surface is curved, you want a spokeshave. Like planes, these tools were originally made out of wood, and the old design is still available. Most of the spokeshaves, today, are metal. The standard spokeshave has a flat face and is suitable for straight and convex shapes. The basic tool has a blade that's held in place with a screw, and the depth of cut is adjusted by lightly tapping the blade forward. Some models have twin adjusting screws for more convenient control of the blade depth. It's often handy to adjust the blade to cut deeper on one side than the other. In this way, you can move the tool from side to side to shift from fine to coarse cutting. When shaping arcs, always pay attention to grain orientation, and move the spokeshave downhill in relation to the grain. For handling concave work, a round- or convex-face spokeshave does the job. Special types include those with blades that are ground either concave or convex across their faces, and have matching body shapes. Chamfering spokeshaves are useful for adding chamfers up to 1½ in. wide. There's even a spokeshave that has a flat and a concave face combined in one tool. Spokeshaves generally cost under \$20.

SPRING CLAMP

When the work doesn't need a great deal of pressure, or the weight alone of typical clamps would prohibit their use, you'd undoubtedly find these spring clamps handy. They're made with openings ranging in size from 1 to 4 in., and the large version costs about \$8. They're especially handy for positioning parts to be joined with fast-setting glues, and for model making and jig construction. You'll even find them invaluable as a third hand for holding things temporarily in place around the house. A plastic coating on the tips and handles is for comfort and to prevent marring.



STROKE SANDER

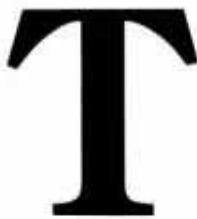
These large machines are designed to sand broad surfaces quickly and uniformly. However, because the operation is predominantly freehand, skill is required for best results. They utilize a long sanding belt that runs from one side to the other. The table on which the work rests slides in and out, toward and away from the operator. An arm-controlled platen that moves across the machine draws the belt to the work surface. By moving the platen back and forth, and the workpiece in and out, the complete surface can be sanded. A medium-sized stroke sander for a 2 x 5-ft. panel costs around \$1500. The larger version shown costs about \$3650.

SURFORM TOOL

Rough contouring wood by hand is the job of these rasp-like tools. The replaceable blades feature a coarse, open-grid tooth structure that cuts fast and resists clogging. The flat Surform tool accepts both flat and convex blades. It's available with handles like a plane as well as the file-type handle shown. The round Surform tool enlarges holes and works in tight curves. These Surform tools generally cost about \$10.

SWAN-NECK CHISEL

This is a heavy mortise chisel that's designed to help clean out the bottoms of mortises. It's effective for mortise-and-tenon joints, traditional latchset mortises, and other situations that require a flat-bottomed mortise. After the sides of the mortise are cut, the bent blade of the swan-neck chisel levers out the remaining waste. It's made in 6-, 10- and 12-mm widths, from \$13 to \$20. Although it has a hoop at the handle top, this chisel is not to be struck.

**TABLE SAW**

The heart of most woodworking shops is the table saw. Equipped with a circular saw blade (10 in. is the most popular size), miter gauge and rip fence, this machine handles most woodcutting jobs. It also accepts dado blades and molding heads. The table saw's forte is in ripping and other long, fence-guided cuts. And, because of its solid construction, the machine is generally accurate and can handle heavy stock. Improved fences and extension tables are available as options on some makes, or as aftermarket accessories to increase the accuracy of your saw. These machines lose points, however, in crosscutting operations. Boards longer than a few feet are difficult to maneuver over the table, and the miter gauge only handles small work. Miter gauges with built-in stock clamps are a good choice for accurate crosscutting. Many woodworkers build a sliding table that fits in the table saw's miter-gauge slots. While this provides better support, crosscutting long boards is still a problem. Sophisticated table saws have built-in sliding tables for accurate crosscutting and panel work. Here, the table is split and the side to the left of the blade rides on a carriage to move the stock by the blade. In addition to miter cuts guided by the miter gauge, table saws can cut bevels. Most saws are tilt-arbor machines—the table stays horizontal while the blade angle is adjusted. Others are tilt-table saws where the blade and arbor remain fixed. In addition to the standard floor-model saws, new compact bench saws combine portability and power. Typical 10-in. table saws range from \$300 to \$2000.

TAPE MEASURE

This modern version of the folding rule comes in lengths ranging from 3 to 30 ft. and has a spring-loaded spool for automatically returning the tape. Longer lengths are available as reel-type tape measures. Standard tape widths are 1/4 to 1 in., and metric, English or combination graduations are available. An average 10-ft. tape costs about \$9.

THICKNESS PLANER

The job of this machine is to plane one face of a board so that it's parallel to the opposite face. It doesn't flatten stock—this chore is handled by the jointer. The typical medium-duty thickness planer has a 3-blade cutterhead with feed rollers in front of and behind the cutterhead that move the stock through the machine. The stock rests on a table under the cutterhead, and is drawn in against the cutter rotation. On some models, the table height is adjustable for stock thickness, and other types have a fixed table and an adjustable motor/cutterhead assembly. Shop-size planers range from small, 6-in., open-sided machines to 24-in.-wide units. Planers that handle about 12-in.-wide lumber are the most common. These generally handle stock up to 6 in. thick, and require at least a 2-horsepower motor for average work. Portable 12-in. planers are available for on-site, light-duty work, and some models are offered in combination with a jointer. Prices for light- to medium-duty planers range from \$500 to \$2000.

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THICKNESS SANDER

While heavy-duty surfacing and thicknessing jobs are usually handled by a

jointer and planer, those rotary cutting tools don't always handle heavily figured wood or wild, reversing grain with tender loving care. And, surfacing thin stock can be risky business at best. To eliminate tearout problems that result in wasted wood, drum-type thickness sanders are a solution. The Performax model shown has a 5-in.-dia., 22-in.-long horizontal sanding drum that's mounted parallel to the machine table. It's designed to

utilize 36- through 240-grit abrasive rolls to handle a wide range of surfacing chores. The top face of the stock is fed under the drum against the drum rotation, and is sanded parallel to the bottom face. The model shown has a variable-speed powered stock feed. For small shops, or when this type of machine will only see occasional use, it's available as an accessory that mounts on the column of your radial-arm saw. This basic version costs about \$300. Heavy-duty industrial thickness sanders are available for production cabinet and furniture shops.

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THIN-KERF BLADE



If you think that your old circular saw is underpowered, trading it in for more horses isn't the only solution. Instead, try strapping on a thin-kerf blade. Because a thin kerf means less wood is sawn away, it takes less energy to do the job. This makes thin-kerf blades especially attractive to cordless-saw users—you'll get longer battery life between charges with this type of blade. And the reduced waste means you could realize a savings when many thin strips, such as edge banding, are being ripped on your table saw. Thin-kerf blades are carbide-tipped, and available for portable and stationary circular saws in the same price range as standard blades. Some models have small bumps behind the teeth to limit the rate of cut.

TRAMMEL



Careful layout and drawing require the right instruments, and this simple tool takes over where your compass and dividers leave off. Basically two scribing points that slide and can be locked on a bar (you supply the wooden bar), it is used to lay out large circles and arcs. The radius is only limited by bar length. And, because it's more accurate than measuring with a ruler when it comes to transferring dimensions, it's invaluable in constructing full-size drawings of furniture, cabinets, boats and other projects. A set of two trammel points can range in price from about \$18 to \$40.

TRIM SAW

The portable circular saws for light-duty trim and panel work needn't have the capacity for cutting heavy 2 × 12 construction lumber. Trim saws have the same features that their larger cousins do, including depth adjustment and a wraparound base that can be tilted for cutting bevels and miters. However, they're much lighter and easier to handle (the model shown weighs about 7 pounds). This small model has a 4½-in.-dia. blade, making it suitable for stock up to about 1¼ in. thick. Because the power requirements of a trim saw are minimal, it is successful as a cordless saw—especially in conjunction with a thin-kerf blade. A typical trim saw can cost \$150.



finishing of surfaces. Skews are angled, straight-edged tools that are used for shaping beads, shoulders and cylinders. Parting tools have V-shaped ends, and are often used to make sizing cuts. Because turning tools are handheld and rest



against the toolrest near the rotating work, the length of the tool affects leverage and tool control. Typical turning chisels are about 17 to 20 in. long, with bowl gouges exceeding 2 ft. for best control. They are available in carbon steel or more expensive high-speed steel and cost from \$9 to \$60.

TURNING CALIPER

Lathe turning often involves making preliminary sizing cuts that bring the work down to critical diameters at specific positions along the stock. Once these cuts are made, they act as a guide for final shaping. This caliper is used in conjunction with a parting tool to make the initial sizing cuts. The standard parting tool is locked in the caliper at the correct diameter by thumbscrews. When held to the rotating stock, the parting tool cuts until the diameter is reached. It costs about \$17, less the turning tool.

TURNING CHISEL

While there are almost as many types of turning tools (chisels) as there are ways to use a lathe, there are a few basic types that all turners are familiar with. Gouges are curved in cross section and are generally used for preliminary shaping and roughing out. Scrapers are flat tools with profiled edges to suit the shape being formed on the work. Roundnose scrapers are common, and asymmetrical side-cutting scrapers are useful for faceplate work and bowl turning. Scrapers are also used for the general cleaning up and



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TRY SQUARE



Just about all of woodworking is based on the right angle. If you can't lay it out and check it, you're lost. A good try square has a wood stock with a brass face on one or both sides for accuracy. The 6- to 14-in.-long blades are steel. Prices range from \$12 to \$50. Engineer's squares are all-steel and are the most accurate. To check a square, hold it against the straight edge of a board, and scribe the square line. Then, flip the square over and check the scribed line against the blade.

TWIST DRILL BIT



The most common drill bit that is used for holes in wood up to 1/2 in. in diameter is actually a metalworking tool—the twist drill. Bits with a smaller point angle perform better in wood than the flatter-tipped metal bits. Twist drill sizes are specified by either a fractional diameter in inches, a number or a letter. Fractional drills start at 1/64 and increase in 1/64-in. increments. Number drills start at No. 1 (.228 in.) and range to No. 97 (.0059 in.), although sets commonly only go as small as No. 60. Letter drills range from A (.234 in.) to Z (.413 in.). A good serviceable set of bits from 1/16 to 1/2 in. in diameter should cost about \$45.

V

VENEER HAMMER



The primary job of this tool is not to strike anything, but rather to press down veneer as it's glued in place. The broad edge is held against the veneer as the tool is drawn across the surface. It's typically used with the grain when possible, and moved in a series of overlapping zigzag strokes. Traditionally, woodworkers would make their own veneer hammers using a piece of brass for the tongue. Several sizes would be kept on hand to accommodate a wide range of work from

broad surfaces to small inlays and cross bandings. The opposite side of the head does qualify the tool as a legitimate hammer—it can be used for striking. This tool costs about \$25.

VENEER SAW



While your dovetail saw may be just the thing for cutting fine joints, it's

not suited for handling thin sheet material such as veneer. For this job, a special veneer saw is available. The veneer saw is usually held against a straightedge cutting guide. The handle is offset for good visibility, and the blade is curved so cuts can be started in the center of a surface. This very thin blade has teeth filed at 13 tpi (teeth per inch), and the teeth are not set (bent for blade clearance in kerf). It costs about \$7.

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Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest legal way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in just 3 years.

You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times:

The Royal Road to Riches is paved with golden tips.

National Examiner:

John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities:

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The Toluca:

You'll love ... *The Royal Road to Riches*. It's filled with valuable information ... only wish I'd known about it years ago!

Hollywood Citizen News:

He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

The Desert Sun:

Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

'More Money Than I Ever Dreamed'

"All I can say — your plan is great! In just 8 weeks, I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year." A. F., Providence, R.I.

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"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright." R. S., Mclean, VA

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

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WISE



No shop is complete without a sturdy vise for holding the work. As opposed to metalworking vises, the wood-working variety is designed to mount under the bench, with the top edges flush with the benchtop. This metal-type vise uses wooden pads attached to the jaw faces. Similar models may have a quick-release mechanism for rapidly opening and closing the vise, and most have a dog that can be raised and used with bench dogs. A medium-sized unit opens to 13 in. and costs about \$120. Bench-vise screw sets are available for making your own wooden vises. Woodworkers who need a standard metalworking vise but have no place in their shop to mount it, can secure the vise to a block, and then clamp the block in the woodworking vise for temporary use.

W

WORKBENCH

A truly useful bench has certain minimum requirements. First, it must be flat so that the work you build on it will be straight and true, and it must be sturdy to resist racking. It should have at least one vise, but preferably two—one at the end with provisions for bench dogs, and the other at one front corner. Finally, it must be sized to both you and your usual work—standard bench height is 33 to 34 in. Additional options include a tool trough, drawers and cabinets underneath. A factory-built workbench costs from \$300 to \$1500. **PM**



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- Delta, 246 Alpha Dr., Pittsburgh, PA 15238
- Freud, 218 Feld Ave., High Point, NC 27264
- Hitachi, 4487-E Park Dr., Norcross, GA 30093
- Laguna Tools, 2081 Laguna Canyon Rd., Laguna Beach, CA 92651 (Robland machinery)
- Makita, 14930 Northam St., La Mirada, CA 90638
- Milwaukee, 13135 W. Lisbon Rd., Brookfield, WI 53005
- Performax Products, Inc., 12211 Woodlake Dr., Burnsville, MN 55337
- Porter-Cable, P.O. Box 2468, Jackson, TN 38302
- Ryobi, 1424 Pearman Dairy Rd., Anderson, SC 29625
- Safety Speed Cut Mfg. Co., Inc., 13460 North Hwy. 65, Anoka, MN 55304 (panel saws)
- SCMI Corp., 5933-A Peachtree Industrial Blvd., Norcross, GA 30092
- Stanley Tools, New Britain, CT 06050
- Skil, 4300 W. Peterson Ave., Chicago, IL 60646
- Vermont-American, P.O. Box 340, Lincolnton, NC 28093

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1302-110

CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



Seizing The Moment

My pickup's clutch seems to be frozen. When I push down on the pedal, it's not disengaging at all. There does seem to be a normal amount of resistance and travel in the pedal—nothing's changed in the feel of the pedal at all. The clutch was kind of sticky for a while, lurching forward a few inches while waiting at traffic lights. Then it got really hard to shift, and then impossible.

I just replaced the clutch disc and pressure plate, and had the flywheel turned as well. The auto parts store where I bought the parts isn't very helpful, claiming no responsibility once I picked the parts up off the counter. Is there some way I can prove it's their fault?

TOM DICKENS
TUSCALOOSA, AL

It's a little bit their fault for not making you buy a new pilot shaft bearing when they sold you the clutch parts.

The pilot shaft bearing or bushing is installed into the center of the crankshaft. It supports the transmis-

sion's input shaft. It should be replaced, or if your vehicle uses a bushing rather than a bearing, re-lubricated any time the transmission is off. Yours has seized. You may have some difficulty separating the transmission from the bearing now, and you may need to replace the transmission input shaft if the shaft's bearing surface is scored.

Removing the bushing can be done with a special puller or by packing the cavity with grease, as illustrated. Tap a bar or dowel the same diameter as the input shaft into the center of the bearing and the hydrostatic pressure will push out the bushing.

Trick TRX

I have a 1980 XR7 Cougar with 20,000 original miles and the original 220/55R390 Michelin TRX radials. Those tires are only available in blackwall, and I think that the car will look too funky without whitewalls.

I was wondering if there are any other tires that will fit the 390 rims. Will a 220/50R15 fit these rims and

seal properly at the bead area?

CARL ASLAKSEN
FAIRFIELD, CA

The patented TRX 390mm rim diameter was chosen specifically to make it impossible to mount conventional-sized tires. The TRX tire/wheel system has a very different profile to the bead seating surface and the tire sidewall, intended to improve handling response without degrading ride quality. Forget about mounting anything but a TRX tire.

So, you have only a couple of options: Buy blackwall tires, or buy new rims in a conventional size. You also might look around for a tire recapper who can apply whitewalls to your new blackwalls.

Plastic Fantastic

I have a 1986 VW Jetta GLI. The plastic radiator doesn't have a radiator cap or a drain valve. Could you recommend a safe and effective way to back flush the cooling system?

SEYMOUR GLASS
BOWIE, MD

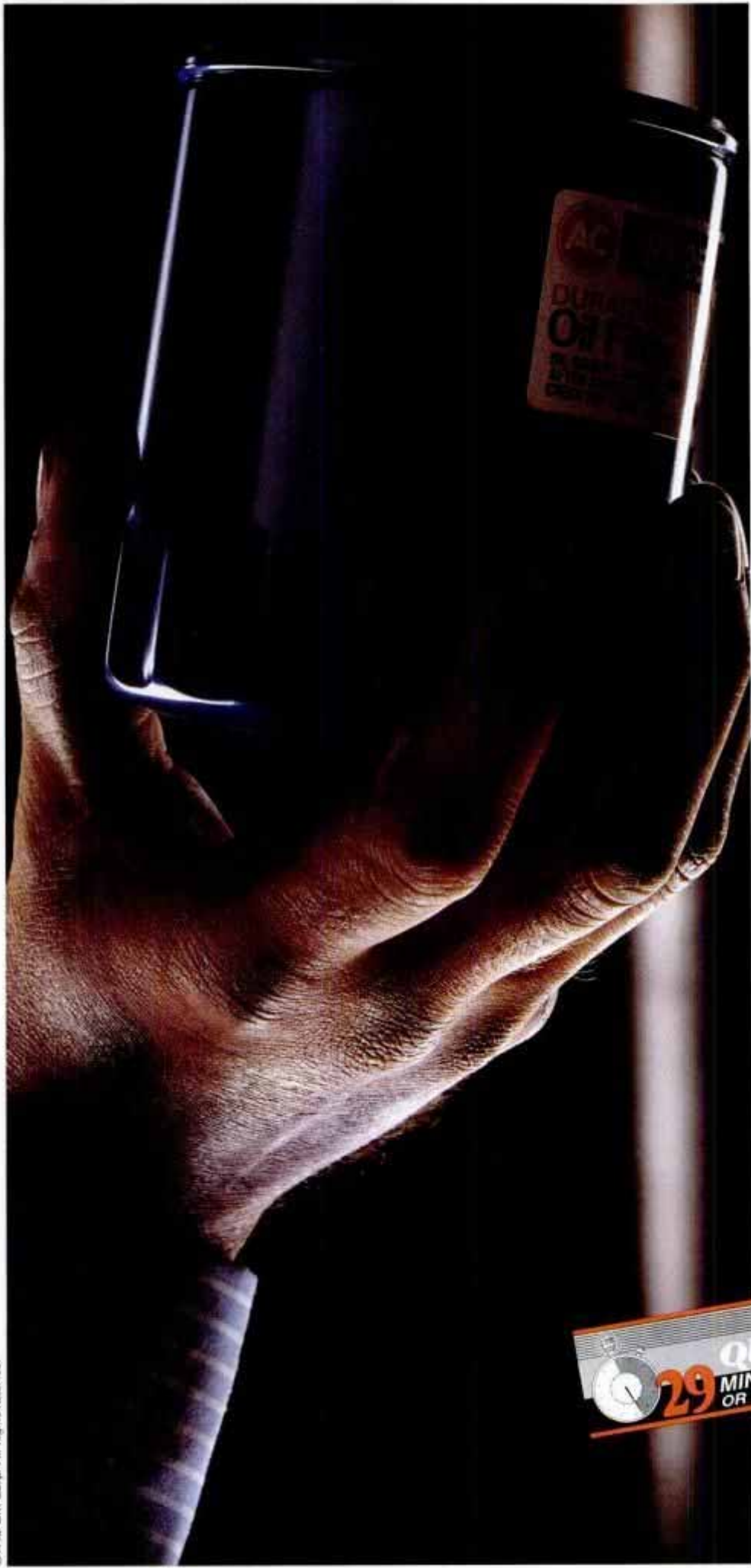
VW says to drain the system by removing the lower hose from the radiator or unbolting the thermostat fitting at the water pump.

Their shop manual doesn't specify any way of flushing the system, but installing a conventional flushing tee into the heater hose ought to work just fine. Just reattach the lower hose/fitting after you've drained the old coolant, remove the pressure cap from the expansion tank, turn on the garden hose screwed into the tee, turn on the heater, and idle the engine until the water spilling out of the header tank runs clear.

Be sure to collect as much of the old coolant as possible and dispose of it in an environmentally responsible manner. It's toxic when ingested. It has a sweet taste so be sure not to let pets or small children swallow any.

After you've drained and flushed the system, shut everything off and drain the water out of the system at the lower hose again. Add 3½ quarts of coolant to the expansion tank, and start the engine. Add water slowly to

(Please turn to page 100)



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EXTRA WINTERGREEN FINE CUT



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CAR CLINIC (Continued from page 98)

the required level. This should give you the recommended 50/50 mixture of coolant to water.

Finished Yet?

I have a problem with my car's finish. I washed it, but the tree sap wouldn't come off. I tried solvents, but those didn't work either. Finally I used a plastic scrubber for dishes, but it scratched the paint. How can I get out the scratches? CHRIS CIESLAK NAPERVILLE, IL

If something like bug and tar remover or kerosene didn't dissolve the tree sap, it's because the solvents in the sap had already eaten their way into the upper layer of paint.

You've complicated the problem by scratching the paint with the pot scrubber. If you have a metallic or base-coat/clearcoat paint, it's going to be tough. You'll have a better chance of rescuing conventional 1-step nonmetallic paint, but be careful either way.

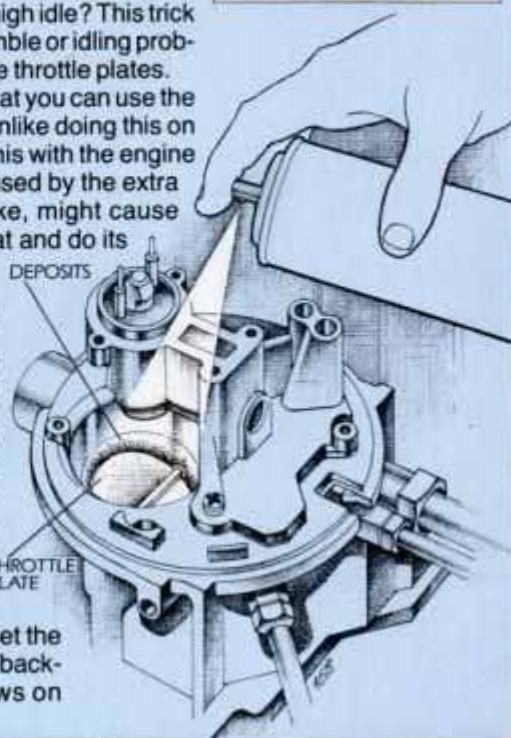
With some 600- or 800-grit wet/dry sandpaper, wet-sand the scratches lightly. Use a rubber block, which you can buy at the auto parts store, designed for automotive use. This

It's A Clean Machine

Fuel-injection throttle bodies are prone to the same gumming and carbon deposits of our old friend/enemy the carburetor. Remember giving the old boat a quick tuneup by spraying a can of carb cleaner into the throats while the engine ran at high idle? This trick would often cure a mild off-idle stumble or idling problem by freeing up airflow around the throttle plates.

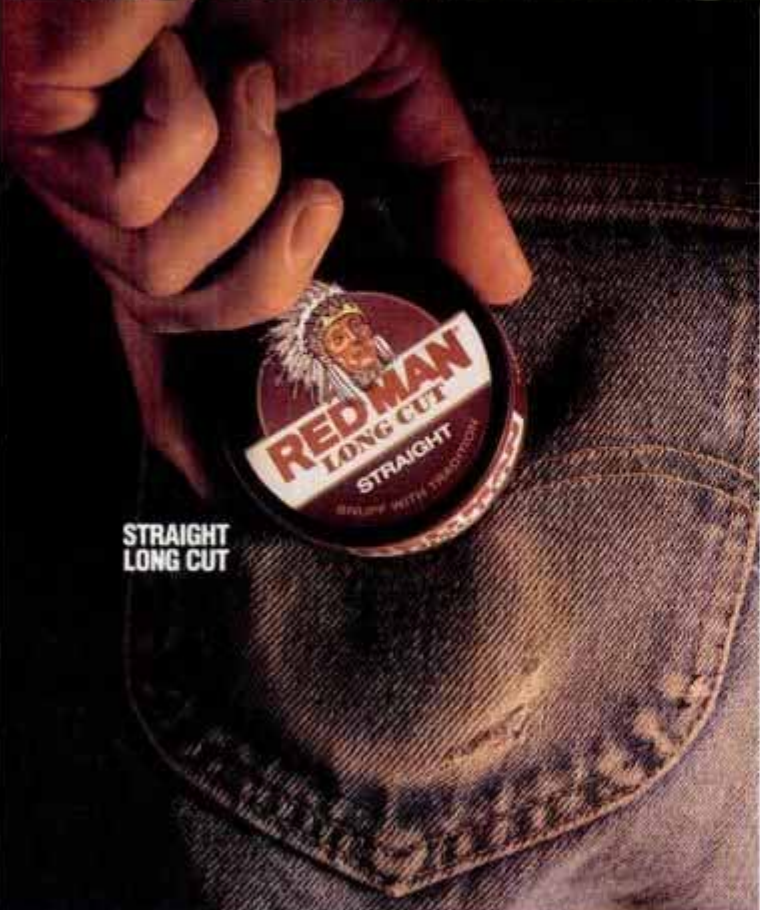
It shouldn't come as a surprise that you can use the same trick on your fuel injection. Unlike doing this on your carbureted vehicle, don't do this with the engine running. The excess richness, caused by the extra fuel you're spraying into the intake, might cause your catalytic converter to overheat and do its own impression of Three Mile Island. Instead, let the car warm up, as the warm alloy throttle-body casting will clean up more easily. Then shut off the engine. Spray the cleaner so that it washes the throttle plate and the gummed-up casting. Let it soak for a minute, then lightly scrub with a shop towel. Repeat the procedure, and then once more with the throttle plate wide open.

Then leave the throttle propped open for an hour or so to let the excess cleaner evaporate, lest a backfire on startup sets your eyeballs on fire.

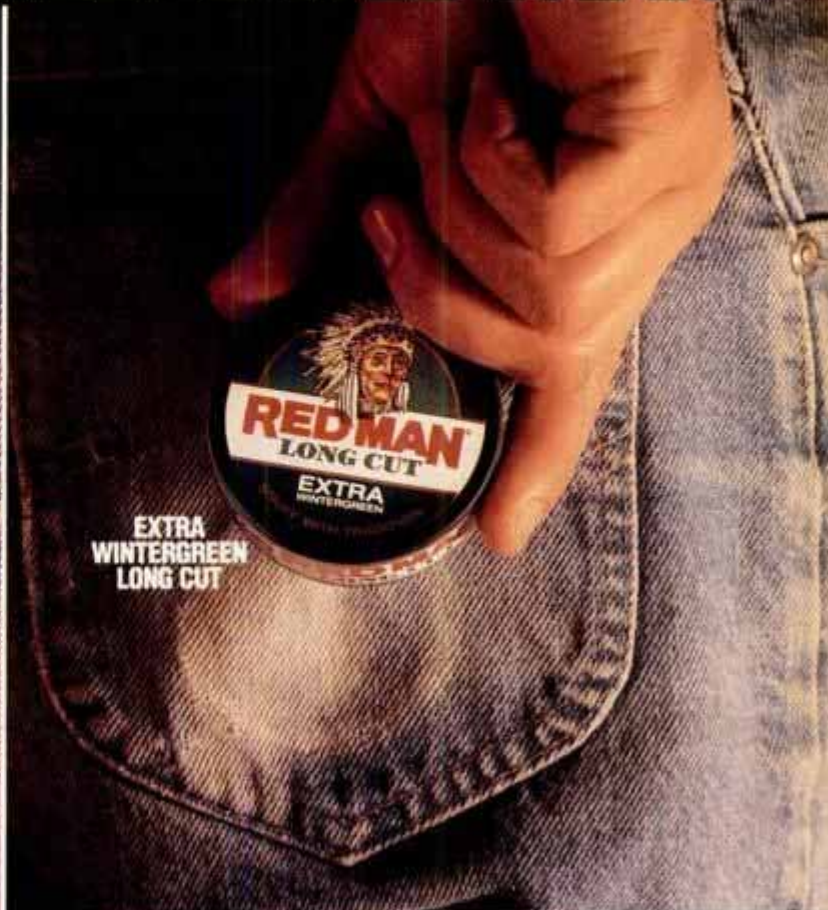


PM ILLUSTRATION BY ADOLPH E. BROTMAN

ENOUGH TO BE CALLED RED MAN.[®]



STRAIGHT
LONG CUT



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LONG CUT

should remove the scratches and the tree sap's lingering memory, as well. Then, carefully compound the area with rubbing compound. This will restore the shine to the surface.

The danger is sanding or rubbing through the thin layer of paint into the basecoat (if it's basecoat/clearcoat) or into the primer (if it's 1-step paint). If so, you'll have to respray the car. It may be better to find a body shop or car detailer who does this instead of experimenting yourself.

And, find another place to park your car instead of under that tree.

His Level Best

The owner's manual for my Chevy specifies checking the fluid level in the auto transaxle with the vehicle level and idling in Park. It also says you can't read the level if you've driven in city traffic in hot weather, pulled a trailer or driven at high speed within the last 30 minutes.

Well, that makes it terribly inconvenient, here where it's over 90° F much of the year. I like to check the level when I pull into a gas station, and I can purchase the appropriate fluid and add it on the spot. Why can't the transmission dipstick be calibrated like the power steering, so it can be

checked with the engine stopped, and have marks for hot and cold?

LOUIS VERGEZ
GRETNA, LA

The dipstick level of the transaxle changes dramatically with temperature, so it's important for the vehicle to be up to operating temp, but not too hot, to check the level of fluid. And the engine needs to be running to keep all the fluid passages inside the transaxle filled—which also affects the level. Otherwise, you'd have to check the level when the engine hadn't been run for hours. The dipstick is calibrated for the most easily reproducible set of conditions—at normal operating temp and idling.

If you've been running at normal speeds on the highway, pulling off into a gas station should see temperatures within acceptable limits. Just don't check the level before the engine and trans have had a proper warmup or if you know things are too hot, like after climbing a long hill. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIPS

■ Chevrolet TSB 89-59-3E outlines procedures for repairing slow leaks resulting from porous spots in alloy wheels. After cleaning and scuff-sanding the affected areas inside the wheel's bead area, coat with a thin layer of RTV silicone and allow to dry for 6 hours. Be careful not to disturb the RTV when remounting the tire.

This procedure ought to work just fine on any alloy wheel, not just Chevrolet's wheels.

■ Got a leaky heater core? Apparently, Ford has found that many heater cores are replaced as leaky, when in fact the leak is simply where the hose is attached to the inlet or outlet tubing. They recommend pressure testing the heater core prior to actual replacement. TSB 87-12-4

■ Ford cars and light trucks that use a plastic axle cover may have a persistent leak if the cover is removed and replaced. It's because the liquid gasket material applied at the factory is difficult to remove cleanly. Apparently, the liquid gasket will seal a flat surface, but not a damaged one. Their solution is to simply replace the plastic cover if there is any leaking.

IMPORTS

BY MIKE ALLEN, Assistant Auto Editor



Autobahn Burner With Style

● Driving the autobahn in Germany is always a pleasure, especially when there's an opportunity to do so in a high-powered German roadburner like BMW's 12-cylinder 850i. When there's no legal limit to top speed except your good judgment and the ability of your right foot to hold the throttle open, driving acquires a few new dimensions.

Such was not the case during BMW's press introduction of the 850i, its new flagship 2-seat techno rocket. In response to environmentalists' concerns, many newer German tourers—and the 850i—are speed-limited to 250 km/h (155 mph). But there is a larger problem—gaggles of 26-hp 2-stroke East German Trabants wandering around aimlessly, taking advantage of the newly opened borders into the land of opportunity in Western Europe.

In spite of these two considerable disappointments, there's still plenty to turn the head about the 850i. With U.S. sales restricted to about 1000 vehicles per model year (a total of 4000—all of which are already sold for the next two model years), the 2+2 coupe is obviously intended to fill the flagship niche in the market lineup. BMW's Rob Mitchell suggested that most 850i buyers are expected to be previous or current owners of 7-series Bimmers, rather than people who are moving up or over from other makes.

At nearly \$90,000, there's not much profit margin—BMW is obviously us-

ing the 850i as proof-of-concept for a huge array of highest-tech performance, safety and comfort systems.

Twelve for the road

Starting with the drivetrain, there's the 12-cylinder engine. Luxury manufacturers like Cadillac and Lexus use V8s for torque and smoothness, but there's another plateau of smoothness associated with the added balance of the extra four pistons. Displacing 5 liters and developing 300 hp, the aluminum-block work of art generates 330 ft.-lb. of torque at 4100 rpm, and starts just off-idle (1000 rpm) with 260 ft.-lb. Coupled to either a 6-speed ZF manual or a computer-controlled 4-speed automatic, the V12 provides incredible flexibility and driveability. Unlike some other performance cars, there's not a blistering sensation of speed—until you look down at the speedo and see triple digits.

Accompanying the large reserve of power is a system for "stability control." Called ASC+T, it supplements the antilock braking system (ABS) by virtually eliminating wheel-spin under any condition, not just under braking. The throttle plates

aren't connected to the accelerator pedal by a cable, as is normal practice. Instead, the pedal position is fed to the engine management computer, which in turn controls the throttle electrically. If rear wheelspin occurs under acceleration, several things happen simultaneously. First, the rear brakes are applied to slow the rear wheels. This happens very rapidly, as hydraulic pressure generated by an electrical pump is already stored in an accumulator. Secondly, the ignition timing is retarded, reducing engine power. Also, the throttle plates are cranked shut. This system ensures optimum power delivery for best acceleration, and will also keep the back end of the car in the back if you hit an unexpected slippery patch in the middle of a bend in the road.

There's a side effect—you can't burn rubber away from a traffic light. Wisely, BMW has installed a switch

(Please turn to page 104)



Multiplexed electrical system reduces complexity and weight.

on the dash to turn off the ASC+T system, as sometimes (that is, in loose gravel or deep snow) artificially limited wheelspin won't get you moving. Driving a car with traction control is almost eerie. Turning off the system on slippery pavement makes one realize how easy it is to overpower a few square inches of rubber. Especially on longer trips, there's a significant lowering of the driver's workload, making for more comfort and safety.

The ABS system operates on one of the most powerful, controllable braking systems we've ever used, readily capable of repeated stops from extremely high speeds with perfect feel. Even jamming on the pedal with both feet, hard enough to activate the ABS, results in little drama—only the speedo needle dropping like a rock. One disadvantage—the brakes are so much better than most other vehicles that there's danger of being rammed from behind. That's a problem we could learn to live with.

Rather than reinvent another active 4-wheel-steering system, BMW has instead gone to a 5-link IRS with passive camber and toe-in control, as well as antidive and antisquat. There's also BMW's proprietary electronically controlled damper system, which, when set to the COMFORT setting, will reduce damping rates to as little as 30 percent of normal. Lateral and longitudinal sensors, and a steering-wheel position sensor can trigger the computer to bump the damping rates up within 40 milliseconds of a turn, lane-change or braking. There's also a SPORT setting, for those of us who prefer a slightly stiffer ride—by no means an uncomfortable one, in our opinion.

Driving an early production 850i through the countryside near BMW's Munich headquarters results in a lot of neck-swiveling, as the distinctive body shape stands out from the usual run of traffic. And it's as quiet a car as we've ever driven. To reduce wind noise, the electric windows run several millimeters up into a channel in the gasket. Open the door, and the motor instantly rolls the window down just enough to clear. Close the door, and about half a second later, the window, moved by an unseen hand, unobtrusively slides back up into the groove on its own. Spooky, but effective.

The inside story

The interior is typically BMW, with large expanses of sculptured plastic.

Technically, there are four seats. We found it difficult to use the rear seat even for luggage, as access past the front seats was next to impossible for any object bigger or heavier than a lunchbox. A taller driver will find the back of the front seat pressed firmly against the rear seats, making occupancy of the rear seats out of the question for even small children.

Part of that can be blamed on the thickness of the front seats. With die-cast alloy frames and more electric motors than a hobby shop, they represent the absolute cutting edge of technology and probably cost more than a Yugo or two. There are the usual array of seat position adjustments, complete with memory function for several drivers, including keying the position of the rearview mirrors.

The seatbelts are integrated into

Every car should have a belt system like the 850i.

Multiplex, not complex

The electrical system is one of the first we'll see on these shores with multiplexing to reduce the amount of wiring involved. With such complex systems, the amount of copper wiring involved would have added considerably to the weight and packaging problems. With the wiring scheme multiplexed, there's only one or two wires connected to any particular switch, actuator or motor. Switches send a digitally encoded signal along the wire, which is received by every other component in the system. A power door lock switch, for example, sends its message along the single wire to the window winder motors, trunk release, power antenna and

many other electrical components. But only the door locks, by means of a small decoding chip, recognize the lock switches' message, and toggle the locks open. Other components ignore the message and remain dormant until their particular coded signal passes by. What has made this scheme possible is the development of small, inexpensive electronics—inexpensive enough to permit dozens of them to be used.

The air-conditioning system has a couple of interesting wrinkles as well. Like a

number of other high-end luxury cars, foreign and domestic, the temperature controls are separated left and right. There's a filter system to remove particles as small as 4 microns, and a sensor to monitor the carbon monoxide, oxides of nitrogen and other gaseous pollutants. Sit for too long at a traffic light behind a diesel bus, and the system will automatically switch to recirculated air—and then back to fresh air once you hit the open road.

The intermittent wipers are keyed to road speed—speed up and they will speed up to match. The ventilation system is similarly keyed to road speed, maintaining the same air volume from a full stop to top speed by shutting off the inlet duct as you accelerate.

BMW's 850i is arguably the most technologically sophisticated and safest vehicle on the road. The sophistication of the Bimmer was especially staggering when we parked at a rest stop next to a pair of wheezing, smoking Trabants—sort of like comparing the Space Shuttle to a coal cart. **FM**



Smooth-as-butter 90° V12 makes 300 hp, achieves 6.8 seconds 0-60 times.

the seat itself—not attached to the floorboards and B-pillar. This makes a lot of sense, in spite of the need for a heavy seat frame and adjuster mechanism to take the added strain in a crash. Putting the belt attach points on the seat rack moves the belt forward and back as well as up and down with the seat, ensuring the belt is always correctly positioned anatomically for maximum comfort and effectiveness. Not only that, but the reel and locking mechanism is in the seatback, not buried down in the floorboards.

The seatbelt locking mechanism snubs the belt itself only a few inches from the shoulder, rather than locking a reel mechanism several feet away. This avoids the "film spool" effect of excess belt length tightening on the reel during a crash and not restraining the torso properly. It also avoids the inherent stretch of the nylon webbing to the same end.

Most importantly, the belt is comfortable to wear for long periods of time—so you're most likely to be wearing it when the crunch comes.



“And then it's Sunday in the pros, and it's you against the world. The fans. The defense. The weather. The expectations. And it doesn't matter, 'cause God gave you a gift to run with the football.”

"Nowhere to Run" A profile of Jim Brown by Mike Lupica

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OUTDOORS

BY JOE SKORUPA, Boating/Outdoors Editor



PM ILLUSTRATION BY TOM FREEMAN

Stripmining The Sea

● Last June, U.S. Coast Guard cutter *Midgett* made radar contact off Alaska with a Taiwanese driftnetter fishing in an area prohibited to Taiwan. The cutter launched its helicopter and observed illegally caught, American-spawned salmon aboard the vessel. As a small approach boat neared, the crew of the *Ta Chieh No. 3* began frantically throwing 2 metric tons of frozen salmon overboard. The evidence quickly disappeared, but the scene was captured on videotape. Documents on board were found to confirm that *Ta Chieh* had illegally fished for the last three years in prohibited areas. Also, the Taiwanese captain admitted to driftnetting in the area even though he knew it was illegal. The fishing vessel was escorted to the Midway Islands and turned over to Taiwanese authorities.

Six weeks earlier, the Coast Guard cutter *Jarvis* chased and boarded the Taiwanese fishing vessel *Cyi Yang No. 1* in prohibited waters. No fish were found on board, but chart markings and salmon fish scales indicated the driftnetter was conducting illegal

fishing activities. The boarding team reported that gold, money, alcohol and sexual favors were offered in exchange for leaving the vessel and forgetting the incident.

In August, the Coast Guard cutter *Morgenthau* intercepted another Taiwanese fishing vessel, *No. 1 Sung Ching*. The holds were filled with American-spawned salmon. The *Morgenthau* was led to *Sung Ching* by agents from the National Marine Fisheries Service (NMFS), who were aboard an undercover vessel, the *Red Fin*, conducting a sting operation.

Posing as fish brokers, the agents arranged for a rendezvous off San Francisco to exchange money and contraband fish. After the money was transferred, the *Morgenthau* came into view and the *Sung Ching* fled, even though two Taiwanese crewmen were still aboard the *Red Fin*.

Eco outlaws

In the last incident, the Taiwanese government refused to allow the Coast Guard to take action as it had in the earlier encounters. Instead, it in-

sisted that a joint boarding must take place off Taiwan. The *Morgenthau* was compelled to follow the rogue driftnetter thousands of miles at a top speed of 8 knots. When Taiwanese authorities finally arrived, they performed their enforcement duties perfunctorily and only after being prodded by the Coast Guard.

What's happening here is a commercial fishing war being played out on the high seas. It pits the Pacific Rim nations—primarily Japan, Korea and Taiwan—against the rest of the world. The weapons being used are a 1000-ship fleet of fishing vessels and the most destructive technology ever invented to catch fish—driftnetting. At stake is the vitality of the oceans.

What stripmining and clear cutting are to land and forests, deep-sea driftnetting is to the oceans. Megascala driftnetting has exploded only within the past 10 years. Yet, it's already threatening to turn the oceans into biological deserts. To complicate matters, there's little international control over this fleet, which sets 30,000 to 40,000 miles of plastic netting each night. And where limited regulations

(Please turn to page 108)



Top hat, white tie¹ and trails.²

The Mitsubishi Montero is the ideal vehicle whether you're putting on the ritz for evenings in the city, or mapping out three weeks in the woods. But you don't have to take our word for it. Simply listen to some of the experts:

1 "As designer utility vehicles go, the Mitsubishi is my new favorite, more fun to drive than an Isuzu or a Cherokee and almost as comfortable as a Range Rover," wrote Michael Jordan in *Automobile* magazine. "It looks tough yet expensive."†

2 *Motor Trend* reports, "On a recent trip to Mt. Pacifico in the Angeles National Forest, we gave the Mitsubishi a thorough workout over dirt, rocks, sand, brush and gravel. On the twisting roads...the four-door's power-assist recirculating ball steering was quick and responsive, almost to the point where it felt like we were pilot-

ing a sports car around the corners."††

"An uncommonly civilized vehicle," wrote *Car and Driver*, "the Montero takes you where you want to go in style, in comfort, and in the right price bracket."‡ Their final judgment: "Best Buy, 1990" in sport utility vehicles under \$20,000.

When professional opinion of a vehicle runs this high, we don't need to add much more than a few specs: Montero's engine is a 3.0 liter, 143 horsepower V-6. Front suspension is independent torsion bar; rear is 3-link coil spring. Hubs lock automatically.

For the Mitsubishi Motors dealer nearest you, call 1-800-447-4700. He'll have a lot to tell you, too.

†4/89 ††11/88 *\$15,519; Mfr's sugg. retail price excludes tax, lic., freight, dir. options and charges. Actual price set by dlrs.

MITSUBISHI 
The word is getting around.

apply, piracy is rampant.

Motivation behind deep-sea drift-netting is profit, of course. Some call it greed. The fleet returns with more fish than ever and earns financiers and brokers hundreds of millions of dollars. Most of the financial backing behind the fleet, reportedly, comes from Japan—a country that put a complete ban on driftnetting in its own coastal waters several years ago.

Wall of death

Driftnetting, or gillnetting, is not a new technology. Nor is it always illegal. Traditionally, a driftnet made of natural materials stayed in one place and waited for fish to strike it. In theory, the fishing is controlled by the size of the mesh. Very small fish swim through it, and very large ones bounce off. Those in between become entangled—usually by the gills.

In the past 10 years, however, a new type of soft, nearly invisible net became mass produced. It's made of high-tensile-strength monofilament or multifilament plastic. Segments, which run to depths of 60 ft., are linked together and set afloat in 30- to 40-mile lengths. To keep the netting open, floats and marker buoys are fixed at the top and weights are fixed at the bottom. The billowy curtain kills virtually everything that comes in contact with it.

Fishing vessels in the United States use driftnets, too. But these smaller vessels work in regulated coastal waters. Their nets are smaller than 1.5 miles in length and they rarely venture into international waters or cross oceans to prohibited zones.

The problems with Pacific Rim, deep-sea driftnetters are that they set down enough net each night to encircle the globe, roam international waters, often enter prohibited areas and are reluctant to cooperate with other nations attempting to manage the world's fisheries.

Since this is a relatively new problem, comprehensive statistics aren't available. But records from four Pacific Rim vessels, which allowed official U.S. observers to take notes in the late 1980s, tell quite a story. The driftnetters set their nets a total of 87 times during the period of observation. In addition to fatally entrapping birds, turtles, sharks and virtually every form of marine life, the driftnetters killed 210 mammals—172 dolphins, 18 seals and 11 whales. On one vessel, the driftnets killed one dolphin for every nine tuna. Imagine the toll taken during a full season of fishing by 1000 vessels. It must be enormous.

Other sources confirm this tale of woe. The National Oceanographic

and Atmospheric Administration recently released a report on driftnet catches from June through December of 1989. Of those catches surveyed, it found that 9173 birds and 914 dolphins were killed. During a trial driftnet fishery in Canadian waters in 1987, one vessel killed more than 200 sea mammals and 1000 birds. After the experiment, Canada refused to permit driftnet fishing in her waters.

Without doubt, driftnetting is profitable, at least until the fishery is wiped out, but it's hardly efficient. In addition to indiscriminant killing of nontargeted animals, the nets are tremendously wasteful. About half the catch either falls into the water as the nets are being retrieved or is crushed to useless pulp by the tons of fish piled above it. Furthermore, fish successfully retrieved are usually damaged and must be sold at reduced value.

Poached salmon

To Americans, especially those on the Pacific Coast, the most immediate problem is the depletion of native salmon runs. By international agreement, deep-sea salmon belong to the country where they spawn.

One Alaskan monitoring organization, the Neet's Bay Hatchery, between 1980 and 1986, recorded that an average of 10.5 percent of salmon released return to native waters to spawn. In 1987, the return fell to 3.7 percent. In 1988, it was only .5 percent. This trend is reportedly mirrored throughout the region.

What happened to the missing fish was that nations of the Pacific Rim began illegally targeting salmon. The practice is widespread, encompasses vast sums of money and involves activities common to the sphere of drug cartels, such as laundering a catch through an intermediate nation to throw investigators off the trail.

Early this year, for example, NMFS agents arrested a Japanese fish broker who had just negotiated a deal to relabel and ship 24 million pounds of illegally caught salmon through Canada and back to Japan during the next two years. Six months later, the agents struck again and arrested a Taiwanese fish broker as he was leaving Seattle with \$1.3 million in cash in a suitcase. The cash was a payoff for 500 metric tons of illegally caught salmon. The man's original offer was for 2500 metric tons.

While U.S. authorities are in the forefront of the poaching enforcement effort, the U.S.S.R. also has a vested interest. In fact, last May, Soviet authorities seized 12 Korean and six Japanese vessels that were illegally targeting Soviet spawned salmon.

The area of the North Pacific that's prohibited to driftnetters is immense and difficult to patrol effectively. It stretches from Alaska to the Soviet Union and encompasses an area the size of the lower 48 states. Last year, through September, 75 driftnet vessels were spotted in the prohibited zone fishing as far as 500 miles north of the line. Of these, 37 were Taiwanese, 26 Japanese and 12 Korean.

When spotted, the poachers frequently dump their illegally caught salmon into the ocean and cut their nets, which creates a new problem known as "ghost fishing." These nets float through the water and continue to kill fish until they become filled with catch and sink to the bottom. Occasionally, they float into the sea lanes and tangle around drive gear, necessitating costly repairs.

Worldwide regulation

Fortunately, for the future vitality of the oceans, most countries of the world favor banning deep-sea driftnetting. In fact, the United Nations passed a resolution calling for a worldwide phase out of deep-sea driftnets by 1992. Compliance with the resolution is voluntary, so pressure still needs to be placed on the Pacific Rim driftnetters. Taiwan, by the way, is not a member of the U.N., and South Korea is a nonvoting observer nation. Japan, while endorsing the ban, agreed only to phase out its South Pacific fleet.

An effective organization was recently formed to monitor the driftnet problem, especially in the North Pacific. It's called SEACOPS (South-east Alaskan Coalition Opposing Piracy) and is located at 700 Water St., Upper Ketchikan, AK 99901. Write or call SEACOPS at (907) 225-8004 for more information or to find out what you can do.

Another organization, Earthtrust, monitors the mid-Pacific near Hawaii. Its scientists and investigators have assembled the most detailed analysis of the Pacific Rim driftnet fishery currently available. Direct inquiries to Earthtrust, 2500 Pali Hwy., Honolulu, HI 96817, or call (808) 595-6927.

Many marine animals take up to four years to reach sexual maturity. Driftnetting is such an effective killing force that entire generations of fish, notably salmon, are wiped out. If salmon from a given river are wiped out four years in a row, that's the end of the river's life as a propagator of the species. It appears that the world is slowly pressuring the Pacific Rim nations into giving up driftnet piracy. Let's hope there's enough time. **PM**

Program published a report on miscarriage rates for 1583 pregnant women who had attended its obstetrics and gynecology clinics. They found that the risk for women who worked more than 20 hours a week at VDTs was 80 percent higher than that for women who did similar work without computers.

Government foot dragging

That's enough numbers. What kind of response has there been from government and industry? According to Slesin, it's been somewhere between underwhelming and actively hostile. Although the data available on ELF to date is far from conclusive, it is strong enough that the EPA, FDA, OSHA and other agencies charged with safeguarding public health should long ago have made a concerted effort to resolve the issue. That hasn't happened. Nor has industry done much besides build up a wall of denial and equivocation. According to Slesin, the lack of constructive effort is attested to by the fact that there has not yet been a single animal study on the effects of ELF fields performed in this country.

Even more troubling than simple neglect have been apparent attempts to actively muzzle any sort of official acknowledgement that ELF fields might be dangerous. The most striking among these came this past March when EPA researchers recommended that ELF emissions be added to a list of probable carcinogens that includes such nasty substances as DDT,

dioxins and PCBs. Although the recommendation was based on two years of study, it was deleted in the final review by the White House Office of Policy Development. Dr. William Farland, who gave the order, said he did so because the classification was "not appropriate at this time." But Brodeur recently told *Time* magazine, "It's a clear case of suppression and politicization by the White House."

At arm's length

Government and industry indifference to the issue is particularly disappointing in light of the fact that relatively simple solutions exist, and they would not necessarily involve complex and stifling regulation. First of all, if people are made aware of the risk, they could avoid most of it merely by keeping a reasonable distance away from their computer screens. ELF emissions drop off rapidly as one moves away from the source, as is borne out by the fact that all of the monitors *Macworld* tested registered less than 1 milligauss at a distance of 28 in. from the front of their screens. That means that simply by keeping an arm's length away from your screen while you work, you can avoid exposure to radiation levels thought to carry risk. Although monitor emissions are stronger through the back and sides, clearances of 3 ft. and 4 ft. respectively should be enough to keep you out of harm's way.

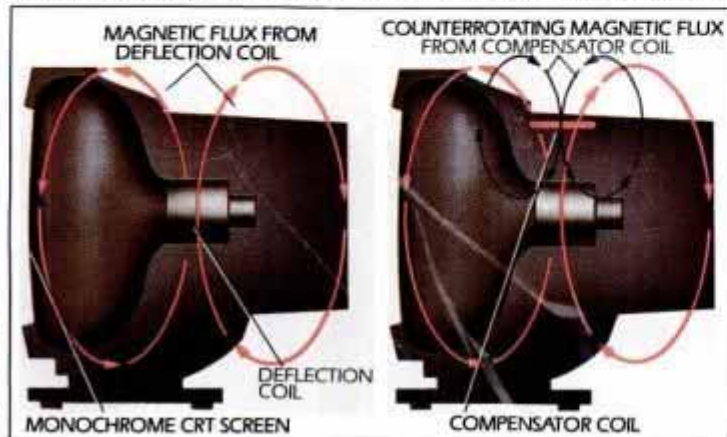
Over the slightly longer term, better solutions will become available in

the form of low ELF monitors. While ELF is impossible to shield against (so forget about lead aprons that some opportunists have been hawk-ing), it is possible to cancel it out. With monochrome monitors, all that is required is some

added circuitry and a compensator coil producing lines of magnetic flux that move in opposition to those from the CRT's deflection coil. Sigma Designs, a Fremont, California-based manufacturer of monitors, has already announced it will introduce a line of monitors next year that will meet strict Swedish government standards for ELF, and slightly higher frequency very low frequency (VLF) emissions. Color monitors are somewhat more difficult to tame because they require a flyback transformer which acts as a second source of ELF emissions. According to Thinh Tran, chairman and CEO of Sigma, it's difficult to counteract the flyback radiation without harming picture quality. Still, he told me, "It takes more work, but it's solvable." The ultimate solution may well be color LCD or electroluminescent displays now under development. Similar to the monitors now on most laptop portable computers, these not only give off negligible ELF fields, they are extremely thin and lightweight compared to CRTs. Although CRTs still hold the edge in cost and performance, research has been stepped up in light of the ELF concerns, and the gap is narrowing.

Slesin points out that once low ELF monitors become available, it will not be necessary for the government to step in with regulations mandating that manufacturers meet certain standards. Simply testing the monitors should be enough. In Sweden, the government does not even publicize the results of its tests, but no one will buy a monitor without knowing what kind of rating it has. As a result, manufacturers include the information in their packaging and advertising, and the ratings have become comparable to the American EPA fuel-efficiency numbers on automobiles, or the Energy Efficiency Ratings now found on air conditioners and other household appliances. With such reliable information available, the buyer is still free to ignore the risks of ELF radiation if he wants to, but at least he has a choice.

And when that happens, computers will go back to being a technology we can all feel good about. **PM**



Counterrotating magnetic flux lines from compensator coil cancel emissions from deflection coil.

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



200-Plus Hp V8 For Grand Marquis

● Starting in the 1992 model year, Ford will install its new 4.6-liter modular V8 engine in the Crown Victoria and Grand Marquis lines. As a replacement for the current 5-liter V8, the engine represents a major advance in powerplant technology for Ford high-production cars. The term modular means that the basic spacing for cylinders can be used in a number of engine types, making it possible to build V8, V6 and 4-cylinder engines on similar manufacturing lines. This reduces costs and offers increased manufacturing flexibility. In the Crown Victoria and Grand Marquis, the new V8 will feature a single overhead-cam valve system, aluminum cylinder heads and accessory mounts cast right into the engine block. Output is said to be in the 200-plus horsepower range at 4600 rpm.

Viper Update

The V10 is definite to be the powerplant in Dodge's ultraperformance Viper, scheduled to hit the showrooms as a '92 model. But the engineers still have a few bugs to work out of the aluminum engine. Current output figures on the dynamometer show 380 horsepower and 510 ft.-lb. of torque. The engineers are working to boost the horsepower to about 400 and lower the torque to below the 460 ft.-lb. rating of the manual transmission. The current Viper prototypes weigh in at around 3100 pounds, and the fat-trimming crew is out to lop off 300 pounds to reach the target weight of 2800 pounds. Chrysler's goal for the Viper is to make it ca-

pable of dusting off ZR-1 Corvettes on a regular basis. Production will be limited to 200 to 500 a year, so many of the cars are expected to be socked away under wraps as collectibles. While it's too early to pin down Viper's eventual retail price, insiders estimate a ballpark figure of \$35,000. But look for dealers to gouge on this one.

Aero Crew Cab

Chevrolet's redesigning of its light truck line is evident in its 1992 4-door Crew Cab model scheduled for a fall '91 introduction. This stretched pickup carries the same aero styling and front-end treatment as the Chevy Suburban and standard pickup. Adequate power will be available with GM's 5.7-liter V8.

Crew cabs are usually used for construction and utility work where both carrying and passenger capacity are equally important. The latter is easily handled by the 1992 Chevrolet pickup's 4-door, double-bench seat arrangement that will accommodate up to six occupants.

Jeeps For Dodge

Dodge will have a nameplate in the booming sports/utility market next year when Chrysler Corporation unveils its ZJ model. Bigger than the Cherokee, the ZJ is designed to appeal to buyers who want the image of 4-wheel drive along with some luxury in their motoring. ZJ is slated for a large V8 engine—probably Chrysler's renowned 318 cu. in.—that has been a big-car workhorse. ZJ will join the growing number of upscale sports/utilities that sell in the \$20,000-plus range, including Olds' Bravada and the Range Rover. Yes, the Dodge ZJ will be a sister to a new top-of-the-line Jeep, a vehicle that will replace the aging Grand Wagoneer.

Move Up To Wood

Jaguar's secret for building luxury interiors can be summed up in three words—wood, leather and chrome. In the past decade, all three materials have taken a beating from substitutes. Plastic replaces wood, plastic replaces leather, and aluminum re-

(Please turn to page 114)



1992 Chevy Crew Cab seats six inside a much sleeker aerodynamic package.

The 1957 Chevrolet Bel Air

Chevrolet



Model shown smaller than 8 1/3" actual length.

A Meticulously Engineered Die-cast Metal Replica of One of America's Greatest Cars.

It was the last of the classic Chevrolets...the most desirable American car of the 1950's...the 1957 Chevrolet Bel Air.

For many Americans, some of their most memorable times were spent in or near this car. Known for its dazzling style, elegant engineering, and brute power, the '57 Chevy embodies the spirit and enthusiasm of the 1950's.

Now, you can own a remarkably detailed replica of this fabled classic car.



Both doors open smoothly, as does the hood. The front wheels turn with the steering wheel.

Hand-assembled...even hand-waxed!

Over 150 scale parts go into the making of this highly authentic replica in the large 1:24 scale. All the important components — the body, chassis, drivetrain and engine block — are crafted in metal.

Each metal part is polished before painting. Every single component is inspected before the replica is assembled by hand. When at last a replica is complete, it is hand-waxed before being released for shipment.

Available only from the Danbury Mint.

This extraordinary replica is available exclusively from the Danbury Mint. It is not being sold in stores.

Send no money now. Simply return the Reservation Application. The price of \$88.50 is payable in three monthly installments of \$29.50 each. If you wish, you may charge your installments to a major credit card.

Reservations are being accepted on a strict first-come, first-served basis. To

avoid disappointment, please mail your reservation today.

RESERVATION APPLICATION

The 1957 Chevrolet Bel Air

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Please return promptly.

Please accept my Reservation Application for the 1957 Chevrolet Bel Air. I need send no money now. I will pay in three monthly installments of \$29.50 each,* the first in advance of shipment.

My satisfaction is guaranteed. If I am not satisfied with my replica, I may return it within 30 days of receipt for prompt replacement or refund.

*Plus any applicable sales tax and \$1.25 shipping and handling.

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Check here if you want each monthly installment charged to your:

MasterCard VISA
 American Express Discover

Credit Card Number _____ Expiration Date _____

Signature _____
Allow 4 to 6 weeks after initial payment for shipment.

N309

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SCIENCE

BY ABE DANE, Science/Technology Editor

Is Your Computer Killing You?

● Until recently, computers seemed like a technology a person could feel good about. They've transformed the world without making a lot of noise, harming the ozone layer or deepening our trade deficit with Japan. What's more, they've been getting better and cheaper at a breakneck pace, and the future seems to hold nothing but promise.

That's why you probably aren't going to like what I have to say next. I don't either. The fact is, however, that over the past 10 years, a troubling body of evidence has accumulated in support of the theory that magnetic fields from cathode-ray tube (CRT) computer displays may be a significant health hazard. As a person who just gave up smoking for the fifth or sixth time, you can bet the last thing I want to hear about is another insidious killer in our midst. But computer screens are looking less and less like something you have to be a health nut to worry about.

Macworld's gamble

Surprisingly, one of the best argued cases against the CRT to date appeared recently in a computer magazine—a bold move for a publication that depends on the hand it's biting for advertising dollars. *Macworld's* July '90 issue contained magnetic emissions tests of several monitors for the Apple Macintosh, accompanied by an extensively researched article by Paul Brodeur, a longtime *New Yorker* writer who was at the forefront of earlier efforts to publicize the dangers of asbestos.

Brodeur's article drew heavily on research by Louis Slesin, editor and publisher of the New York-based newsletter *VDT News*. I interviewed Slesin to get a closer look at the problem of CRT emissions, which he has been following for 10 years.

Evolution of the ELF debate

The groundwork for today's concerns was laid during the late '70s, when studies began to suggest that expo-

sure to certain types of magnetic fields from power lines and other high-voltage electrical apparatus coincided with unusually high levels of cancer. Among the most influential of these was a 1979 report in the *American Journal Of Epidemiology* that showed children living near high-current power lines in the Denver area died of cancer at twice the normal rate.

Suspicion as to the cause centered on extremely low frequency (ELF) magnetic fields in the 60-cycle-per-second range, which the researchers measured at levels of 2 milligauss (a milligauss is an extremely fine measurement of magnetic field strength) or more in the affected homes.

Earlier, such small amounts had been thought harmless, but little research had been done. Residing below the longest radiowaves in the little understood lowermost reaches of the electromagnetic spectrum, ELF radiation is capable of traveling only relatively short distances, but it penetrates anything that stands in its way, with unknown effects.

The link between ELF and computer monitors was established in 1982.

A study by Dr. Karel Marha of the Canadian Centre for Occupational Health and Safety found 60-cycle-per-second ELF fields at levels greater than 2 milligauss at a distance 12 in. away from the two monitors that his group tested.

With computers now tied in to the broader debate over ELF fields, the evidence of danger from these emissions continues to grow stronger. A *New England Journal Of Medicine* article also published in 1982 showed that workers in 10 out of 11 occupations that exposed them to electromagnetic fields died of leukemia at greater than expected rates. And just last year, Johns Hopkins University came out with a study showing that New York Telephone cable splicers had seven times the incidence of leukemia that other workers in the same company had.

Although European researchers have performed numerous studies focusing directly on the effects of ELF fields from computer monitors, only one major epidemiological study on the subject has been performed in the U.S. In 1988, the Northern California Kaiser Permanente Medical Care



PM ILLUSTRATION BY HANK KEN

places chrome. But most luxury cars still offer the real thing. And it costs. Infiniti had a solution that may have backfired. Its cars were purposely designed without wood trim—at least that was the plan for Infiniti's first year.

"We think the trend is away from wood in luxury sedans," an Infiniti designer told me. Watch for the company to reverse this decision soon because wood is too attractive to pass up. Ask Audi designers. They followed a no-wood policy until their flagship V8 sedan was introduced last year. As for real wood versus plastic lookalikes? Many agree that if you have to study the material in the car to tell the difference, does it matter?

'C' For Caddy

The '92 Cadillac Seville receives a totally new body and chassis that's based on the Caddy De Ville. The major change to Seville's appearance is more rounded, aerodynamic styling. Under the hood will be the new Northstar 4.9-liter dohc V8. The new chassis, that Seville shares with its stablemate, Eldorado, is the existing front-wheel-drive De Ville C-body platform. Compared to the current Seville model, the '92 version will be



1992 Cadillac Seville will have a longer wheelbase and be lower and wider.

lower, wider and will ride on a longer wheelbase.

Breaking Rods

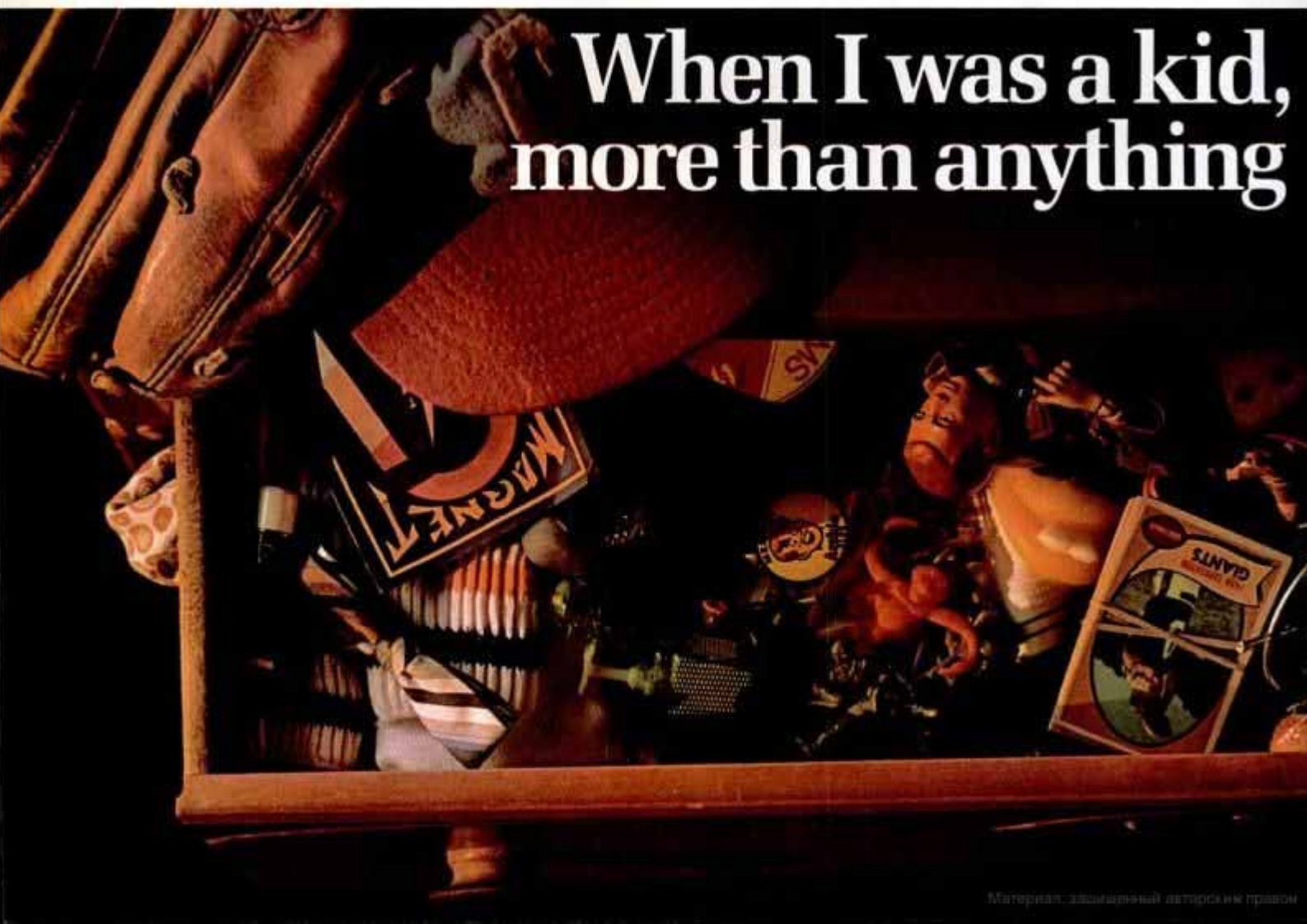
Ford has a new (to high production) technique for building quality piston rods. The crank ends of the rods are literally broken off, not cut off, after casting. The inside of the bearing cap is scored on opposite sides of its circle. Then the rod is held in place while a hydraulic press breaks off the end. While the break is clean and true along the scored line, the remainder of the break has an uneven surface. Matching these uneven surfaces when the cap is bolted back to the rod results in perfect alignment. In addition, there is no loss of material where

the cap meets the end of the rod, so that the original cap to rod dimensions are unchanged. Ford uses the broken rod process on its new modular 4.6-liter V8 that powers the Town Car.

Toronado, Riviera Split

Major changes are planned for both Toronado and Riviera beginning in the 1994 model year. The two coupes will go their separate ways at that time, with the Toronado switching to a 4-door body style, while the Riviera takes on a new look in 2-door coupe and convertible body styles. The split of Toronado and Riviera ends a long-time sharing of a single 2-door body by the two cars that can be traced back to the late 1960s. The decision to

When I was a kid, more than anything





1993 Ford Tempo moves away from the soft Taurus look to more angular styling.

separate the two models is attributable to GM's determination to build distinct personalities for Olds and Buick. Note that Riviera's future convertible is a 4-seater and is not seen as direct competition to Buick's other luxury softtop, the Reatta.

Cars On A Diet

One of the best ways to improve fuel economy is to build cars that are lighter weight. This route has been followed for the past 15 years in the auto industry, with great success. In 1975, the average car weighed well over 4000 pounds. Today, the average is between 3000 and 3500 pounds. Yes, the smaller cars make a big difference. Their bulk is less, engines

are half the size, and chassis/drive-train parts are tiny by comparison. But the wider use of high-strength steel and lightweight plastics and aluminum are important, too. Now engineers are concentrating on new basic techniques to make more reductions.

The dieting science has reached a point where the use of laser welding is being considered as a way to build lighter parts.

Upbeat Tempo

Dual quads in

automotive circles used to refer to a carburetion system. The '93 Ford Tempo will have dual quads, but they will be headlights—four per side—not carburetors.

The mini-sized lights, along with more angular styling (Ford is moving away from the aero Taurus look here), will be the eye-catching features on the new model.

Drivelines also come in for an upgrade with a 3.0-liter V6 in the offing. Mercury Topaz will get the same treatment when both models make their debut in mid-'92.

New Look For Suburban

Here's what the restyled Chevy/GMC Suburban will look like for '92. The big

(Please turn to page 116)



'92 Suburban gets sloping hood and either gas or diesel power.

I wanted one thing else in the world.





1992 Cadillac Eldorado prototype's disguise didn't stop us from sleuthing details of larger size with horizontal-strip taillights.

hauler moves to a more rounded look with a sloping hoodline. Engines available will be the 5.7-liter V8 gas and 6.9-liter diesels. Both 2- and 4-wheel-drive versions will be offered. All this carrying capacity won't come cheap, as prices are expected to be in the mid-\$20,000s. Suburban's biggest sales, by the way, are in Texas.

Eldorado, 1992

Caught outside its security grounds is this heavily disguised prototype of the newly designed 1992 Cadillac Eldorado. Beneath the misleading paint job and the extra panels over the rear

windows, the car appears larger, longer and better proportioned than the current Cadillac luxury sports coupe. In final form, the grille will be chrome plated, and the taillights will be horizontal strips instead of boxlike forms. Under the hood will be Cadillac's soon-to-be-announced Northstar aluminum V6 ohc engine that will punch the Eldorado's front-drive chassis with 200 or more horsepower.

Saturn Fights For Quality

Saturn cars use parts made by overseas suppliers, including some from

Japan. The idea is to use the same high-quality parts that you find in Hondas and Toyotas. But Saturn found that delivery of top quality is not automatic. "We had to go back to those suppliers more than once before we got the kind of quality we wanted—the same level they supply to Japanese carmakers."

Droop Snoots

The strongest styling trend in pickups and sport/utility vehicles is a Japanese invention. Toyota and Nissan have made the downward-sloping hoodline popular. So much so, that

But I had to grow up to get it.

An aggressive stance.

The journey from training wheels to a place behind the wheel of a new Ford Mustang GT was a long one. And worth it. Because, from fog lamps to rear spoiler, this sports car looks as impressive as its long-standing reputation. The shape of its sheetmetal alone can make a grown-up feel as excited as a kid on Christmas.

A serious interior.

Inside, the true Mustang enthusiast can conduct the business of driving without distraction. Information is relayed cleanly across the GT's tach, and other analog gauges. The seats are firm, articulated sport buckets with power lumbar support. Leather trim is an option.

225 net horsepower, high-output V-8.

225 net horsepower at 4200 rpm and 300 lbs. ft. of torque at 3200 rpm. Enough said.

A firm grip on the road.

Gas pressurized struts up front. Quadra-shock system in the rear. Performance tires mounted on 16" cast aluminum wheels. And a smooth-shifting five speed. All designed to keep Mustang GT glued to the road while delivering a performance that'll keep you glued to your seat.

Ford Mustang GT. Ain't it great to be grown up?

Safety first.

Every Mustang GT comes with Ford's standard driver's side air bag supplemental restraint system to be used with your safety belt.

Ford Mustang GT

Have you driven a Ford...lately?



Buckle up—together we can save lives.

GM and Ford are copying the shape for their future compact trucks. Ford's Ranger will offer a hoodline that curves downward just as sharply as Toyota's. Ranger's new look makes its appearance as an early 1992 model. Chevy's S-10 Blazer and GMC's S-15 Jimmy will also get the droop-hood treatment, on new designs scheduled at the same time as Ranger's. A sloping hoodline does create some aerodynamic advantage and improves the driver's view of the roadway, but it is styling fashion that seems to be the big impetus behind this trend.

Olds Cutlass Supreme

Grand Prix and Lumina introduced high-performance coupes powered by 3.4-liter dohc 24-valve V6 engines for 1991. Next year it is Oldsmobile's turn. This performance-trimmed 1992 Cutlass Supreme will be just as hot as its GM-10 cousins, with a high-powered engine and choice of automatic or 5-speed manual transmission. Note the distinctive dual tri-lights. Their smaller size permits a longer, lower hoodline and a unique front appearance. Olds is developing this car for the 1992 model year, but don't be surprised to see it show up as a half-year model in 1991.



'92 Olds Cutlass Supreme gets the same 3.4-liter, 24-valve V6 as the '91 GP and Lumina.

Smaller Headlights

In the race to adopt new faces for their models, auto designers are concentrating on the shape, size and visibility of headlights. First was the trend toward hidden headlights. Then came the composite lights that curved in harmony with the shape of the fenders and hoods. Today, smaller is what the designers want on the front ends. You'll see smaller rectangular head-

lights on new General Motors cars like Grand Prix and Cutlass Supreme and on Ford's future Tempo and Topaz. If there is a phase going out of style, it is the hidden headlight. That's because they lend little in the way of special styling and impart a strong lookalike appearance. The happy medium seems to be the newer, smaller composite lights that fit the contour of the sheetmetal. **FM**



HOME VIDEO

BY STEPHEN A. BOOTH, Contributing Editor



Home Broadcasting

● More than five years ago, I reported on an item called the Quantec VideoCaster ("Electronics Monitor," page 16, May '85). The hockey-puck-shaped device was designed to transmit pictures and sound from a VCR in one room to a TV screen in another—without wires.

Shortly thereafter, the Federal Communications Commission K.O.'d the product and others like it. At the time, the FCC did not want anyone to operate a minibradcast station in the home. Recently, the commission reversed its K.O. and okayed low-power, wireless audio/video distribution systems for the home by allocating radio spectrum in the 902-928 megahertz band. Already, four companies have introduced products that will let you send a signal from a VCR in the living room downstairs to a bedroom TV upstairs.

These wireless products are similar in setup and operation.

An AC-powered transmitter module connects to the video and audio output jacks of a VCR (or videodisc player, camcorder, satellite TV receiver). On the remote TV, a receiver module is linked to the set's RF antenna input. The signal passes unimpeded through walls, structural steel, concrete and other obstacles.

Transmitting range varies from manufacturer to manufacturer. Fox says its Remote Video System (\$150) can operate over a 250-ft. range. Recoton's Room Service (\$100) travels 150 ft. while InnerView (\$99), from Universal Security Instruments, goes 100 ft. Gemini claims 120 ft. for its \$100 system—ironically, dubbed Videocaster. For homes with multiple TVs, each manufacturer offers separate accessory receivers for about half the price of a complete system. Only one transmitter is needed at the VCR or other distribution source.

Although ads tout the wireless transmitters mostly for movie-watching away from the VCR or videodisc player, they'll work as closed-circuit surveillance systems with camcorders, too. For example, parents can monitor a sleeping baby by attaching a transmitter to a camcorder in the child's room and a receiver to a TV elsewhere in the home. In fact,

we found this to be the most practical use for a wireless transmitter. If you've already invested in a camcorder, it probably sits around doing nothing most of the time. You might as well give it gainful employment as part of your private closed-circuit TV system. If your TV has picture-in-picture capability, you can monitor the camcorder image on the inset screen. If not, a simple A/B switcher lets you change between the camcorder signal and whatever else you're watching.

How good is the picture and sound quality from these wireless transmitters? Are there any compromises for their convenience or for the savings over the cost of a second VCR? To find out, we tried out the first model to hit the market, Universal Security Instrument's InnerView Model V-9900.

With transmitter and receiver rotated through a variety of remote locations, inside and outside the home, the V-9900 relayed sharp color pictures and clear sound. Any distortion was easily cleaned up by adjusting the fine-tuning control on the receiver module.

Quality compromises were minor and easily overlooked. For one thing, sound can be transmitted only monaurally. For another, when you connect the transmitter to, say, your VCR, you must use the VCR's RCA-type video- and audio-output jacks. This means you're forced to use an RF hookup between the VCR and its connected TV—from the VCR's antenna output to the TV's antenna input. Direct A/V connections are a bit cleaner than RF, but again, it's not a major annoyance. And you can always restore the direct link when the wireless transmitter isn't being used.

One small inconvenience of remote viewing is that you must sacrifice remote control—infrared devices operate only on line-of-sight. Consequently, you won't be able to put your VCR into pause or fast-forward through commercials when you're viewing in a room other than where

(Please turn to page 120)



Transmitting range varies with different models. Gemini (above) promises 120 ft., while Universal claims 100 ft.



WHO CAN YOU TRUST?

MetLife, of course. From paying claims promptly to providing expert advice, we'll always be there when you need us.

GET MET. IT PAYS.




The MasterMind from HTS can control up to four components.

the VCR is located. Unless, that is, you invest \$199 in the MasterMind zapper from HTS.

MasterMind is one of those remote controls that can learn and imitate the commands of other remotes—up to four in this case (TV, VCR, cable-converter box and one more). But it goes a step further—actually 200 ft.—through walls and other obstacles. That's because the MasterMind uses UHF signals to transmit commands to equipment in another location.

A small, sleek transponder module stays in the room where the VCR and other equipment is located. When you use the remote to send a command from another location, it is transmitted to the module via UHF radio-

waves. The transponder converts the radio signal to infrared and passes the command along to the VCR.

HTS didn't develop MasterMind to complement wireless audio/video transmitters like the V-9900, though complement them it does. Rather, it's intended to extend your control over IR remote-controlled devices.

As such, it has some intriguing applications. Let's say you've got an IR remote-controlled VCR and TV in one room, and an older TV that lacks remote control elsewhere in the house. MasterMind and a little coaxial cable can update the older set to remote-control convenience.

Just snake the coax through floorboards or walls to make an RF connection between the VCR's antenna output and the older TV's antenna input (if you're already using RF between the VCR and its connected TV, just put an inexpensive splitter in the line). Tune the older TV to Channel 3 or 4—whichever is unused in your area. Now, your older TV can display whatever the VCR is playing—from tape or TV tuner. And with MasterMind controlling functions of the remote VCR, you've got remote control over the older TV, too.

New Tapes And Discs

When dubbing from one videotape to another, keep in mind that it helps to use a good quality tape. Among the most recent entries are two new for-

mulations from Fuji and Sony.

Fuji is using what the company calls a unique double-coated manufacturing process for its new tape. One layer is designed to enhance mid- and high-frequency response so as to improve video reproduction. The lower layer is designed to enhance the audio reproduction.

Sony, meanwhile, is introducing its V-line of videotape with a barrage of fanfare. The V-line uses a high packing technology designed to increase the density of magnetic particles, on the tape. The greater the density of the magnetic particles, the better the picture quality is likely to be. A high density also means there should be fewer dropouts, or instances when bits of the picture disappear.

All of us have fiddled with the brightness, contrast, color and hue controls of our TVs in order to improve the picture. The problem is that we have no frame of reference against which to compare our efforts.

Reference Recordings now offers the only video calibration material available to the general public. "A Video Standard" is available only on laserdisc for \$60. The disc includes a wide variety of audio and video tests useful for setting up everything from a surround-sound system to checking the color convergence of a projection TV. Write Reference Recordings, P.O. Box 77225X, San Francisco, CA 94107. **PM**

Editing Your Home Videos Gets Easy

● With camcorder ownership at the point where a TV show relies on the public for homemade videos, and news organizations solicit amateur footage, Americans seem to be a step away from doing their own post-production work.

Perhaps the only thing preventing camcorder owners from moving into the video-editing suite has been the relatively high cost of editing gear. Sima, a well-known video accessories company, is changing all of that.

Sima offers two low-price video editors called the Ed/it 1 and Ed/it 2 for a list price of \$130 and \$180, respectively. The difference between the two is simple: The Ed/it 2 allows you to add audio tracks to your footage, while the Ed/it 1 does not.

For our money, the ability to add background music, narration, and even to put words into people's mouths is what makes a home video fun, enjoyable and, most importantly, viewable. Narration is added with a stereo microphone included as part of the Ed/it 2 package. Inputs are provided so you can

plug in a tape recorder or CD player to add music. Volume levels are adjusted by using the slide controls.

The Ed/it 2 is also impressive in the number of video sources you can tap. There are two sets of audio/video inputs so that you can mix material from a VCR



and a camcorder, for example, onto a second recording VCR. A source select button makes switching between machines easy.

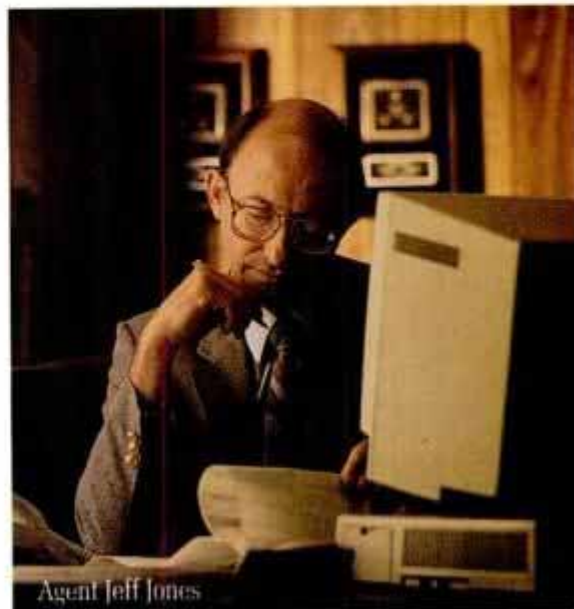
While you can always do quick cuts between scenes, the Ed/it 2 has an

autofade function that provides some directorial flexibility. When you press the autofade button, the video fades out to a dark screen in 3 seconds. Pressing the button again brings the picture back in 3 seconds. This is a useful feature for making transitions from one locale to another or to indicate a sense of time passing. Keep in mind that many camcorders have many special effects and titlers built in so you don't necessarily need them on the video-editing machine.

We were also impressed by the video enhancement feature. This slide control can boost the video signal as much as 6 decibels. In our examination of the Ed/it 2, we used a tape copy of video material dubbed from a laserdisc as our source. By manipulating the enhancement control, we were able to restore much of the color and brightness that's usually lost in the dubbing process. As the manual says, too much enhancement can distort the picture altogether. Used judiciously, though, the enhancement feature, like the Ed/it 2, is a winner. —Frank Vizard

Paoli, Indiana since 1972:
3,650 people,
1,260 babies,
2 floods,
2,647 auto claims

...and 1 State Farm agent.



Agent Jeff Jones

Paoli's not a big city by any stretch. But even in a small town like this, things keep changing. They put up a new church not far from the courthouse last year. Families are building houses. Babies are being born. And every time something changes, someone's insurance coverage needs reviewing. That's where Jeff Jones, Paoli's State Farm agent for the last 18 years, comes in.

Like State Farm agents across the country, Jeff offers all his policyholders a free State Farm Family Insurance Checkup. That helps them make sure that no matter what's changed, their insurance coverage won't be out-of-date. Whether it's auto, home, life or health insurance.

In 18 years, about the only thing in Paoli that hasn't changed is Jeff. And that's the way folks in Paoli like it.



Like a good neighbor,
State Farm is there.

State Farm Insurance Companies
Home Offices: Bloomington, Illinois

OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



A wide variety of books is available for restoration enthusiasts, including the three titles, published by the Preservation Press, shown at left.

Painting the lady

Perhaps nothing has a larger impact on a Victorian restoration than the colors you choose to paint it. More than curbside appeal, the painting of a Victorian can make or break your project. An excellent book that will help you achieve a successful paint job is *Exterior Victorian Decoration, How To Paint Your Nineteenth-Century American House Historically*, by Roger W. Moss and Gail Caskey Winkler (Henry Holt and Co., New York, NY 1987; \$29.95).

Thanks to Moss and Winkler's research, the hitherto daunting job of selecting colors for your grand old dame is now a very pleasant one. They've broken down the process into seven steps, beginning with obtaining manufacturers' color cards and ending with buying one can of each selected color and applying it to a sample area where the body, trim and sash colors can all be viewed together.

The book includes a color chart (part of Step 2) that lists the 34 common Victorian colors along with today's nearest equivalent colors. This helps narrow the choices for the Victorian painter in today's exhaustive paint world. Another helpful chart, the Color Affinity Chart, shows what trim colors were considered appropriate for each base color.

In addition to aiding color selection, the book details its proper placement. This includes the treatment of Victorian architectural elements, like pilasters, cornices, panels and vergeboards. How to paint windows, shutters and doors, along with the proper treatment of the often forgotten roof and foundation, are also discussed. So are the ways to pick out the detailing of those glorious Victorian porches.

For those who desire the brightly contrasting painted-lady look, *Daughter Of Painted Ladies: America's Resplendent Victorians* by Elizabeth Pomada and Michael Larson

(Please turn to page 124)

The Restoration Bookshelf

● A good book is like a good friend—always there when you need advice or guidance. Over the years I've been writing this column, I've occasionally recommended a book or two I found helpful for one restoration project or another. This month, I've gone back through my files and pulled out those I feel warrant another mention.

Stacked on the desk in front of me, I see that most of them deal with one facet or another of interior decoration. I'm talking about things like deciding how to paint or stencil a room, and selecting period floor and wall coverings, light fixtures and hardware. Some of these projects are those I consider the most fun (and the simplest) for many readers. There are also a couple on exterior decoration, namely Victorian house painting.

A brief synopsis of the material each book covers should help you decide which are must additions for your restoration bookshelf.

The restoration bible

I'll begin with the one book I consider the bible of the restoration industry, *The Old-House Journal Catalog* (Old-House Journal Corp., Brooklyn, NY, 11217; \$15.95). It's compiled and edited by the staff of the magazine with the same name. No matter what

part of the old house you're restoring, it's an excellent place to begin your search for supplies and services.

The catalog is broken down into sections that cover most areas of interior and exterior restoration. Although it's impossible for me to discuss every one, I'll try to give you an idea of the broad range of restoration products and services easily located between its covers.

For example, the chapter on exterior building materials and products includes where to find roofing and siding, while the one on decorative interior materials and supplies locates things like ceiling medallions, moldings and cornice.

You'll also find listings for companies that sell things like period doors, lawn furniture and house plans, along with those who restore and sell antique stoves. The book also includes antique architectural salvage shops and architectural design and consulting firms.

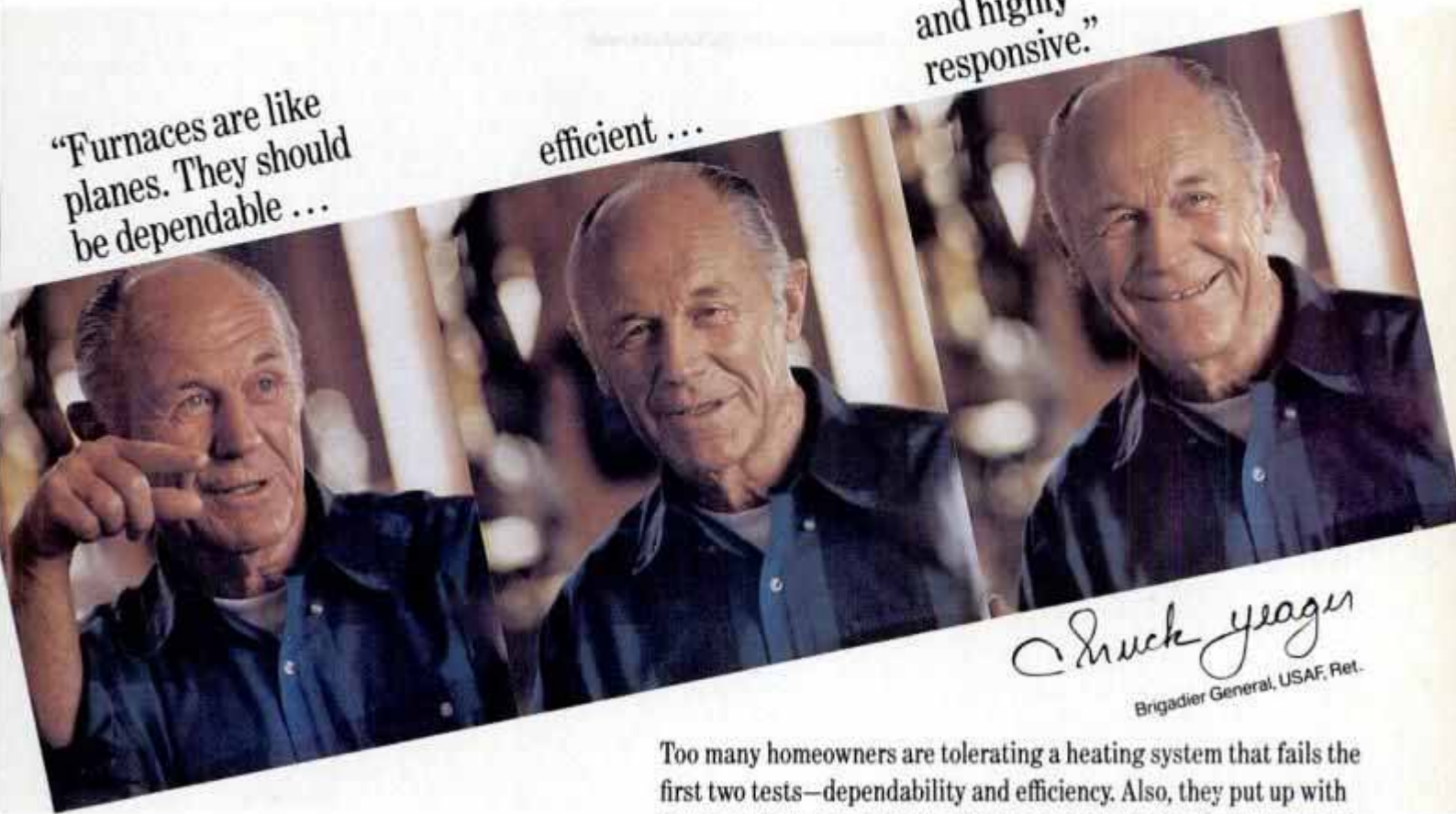
And, of course, the catalog lists places to find supplies for the interior restoration projects I mentioned above: stencils, wall and floor coverings, period hardware and light fixtures. You'll also find manufacturers of historical paint colors. Along that line, if you're thinking of painting an old Victorian, the next two books I'll discuss should be of particular interest to you.

Contributing Editor Bob Vila hosted public television's "This Old House" for 10 years.

"Furnaces are like planes. They should be dependable ...

efficient ...

and highly responsive."



Chuck Yeager
Brigadier General, USAF, Ret.

Too many homeowners are tolerating a heating system that fails the first two tests—dependability and efficiency. Also, they put up with furnaces that respond to heating needs with blasts of warm air and then long periods in which the air cools off.

The folks at Bryant have developed a furnace that automatically adjusts its heat output while operating at maximum efficiency. It's the Plus 90i. No cold drafts. Just constant, even, comfortable warmth. Furthermore, unlike any other furnace, the Plus 90i operates with less electricity, as well as gas. No other furnace is more efficient. Or quiet.

As test pilot Chuck Yeager puts it, "There's never an uncomfortable moment with this furnace. That's what I call having the right stuff." Ask your local Bryant dealer about it. He has the right stuff, too.

For the name of your nearest Bryant dealer, call



1-800-HOT-SALE.

bryant[®]

THE RIGHT STUFF TO LAST.



For comfort you can afford,
choose gas—America's
favorite way to heat.

(E.P. Dutton, New York, NY 1987; \$15.95) is a good source of ideas and examples. The more than 170 color photos of delightfully painted Victorians from various parts of the country, along with your own inspiration and imagination, will help you create your own version.

Once the outside of the house is set, it's time to start thinking about the interior. Let's take a look at some books that will help you add period charm to your rooms.

Period decoration

There are numerous ways to give your rooms the period feel your restoration is striving for. Of course, how you decide to treat your walls, floors and ceilings plays a large part in a successful interior restoration.

If you're trying to recreate, in an old Victorian, the feel of days long gone, a good book to help you achieve this goal is *Victorian Interior Decoration, American Interiors, 1830-1900*, by Gail Caskey Winkler and Roger W. Moss (Henry Holt and Co., New York, NY, 1986; \$35). Experts on Victoriana, they're the same folks who wrote the book on painting I mentioned earlier.

Based on the advice of 19th-century designers and critics (the same voices our homes' original owners probably looked to for decorating advice), this book is broken down into four chronological periods. Each chapter discusses the way floors, ceilings, walls, woodwork and windows were treated. The design information will help you understand how your house was meant to be decorated and help you make wise decisions based on the level of authenticity you're striving for.

A couple of books from the Preservation Press (Washington, D.C.) take two of these design elements a step further, namely that of choosing period wall and floor coverings. If you're trying to select wallcoverings for a house built between 1700 and 1910, Richard C. Nylander's *Wallpapers For Historic Buildings*, (1983, \$13.95) is must reading for you. A virtual catalog of period papers, this book lists more than 350 authentically reproduced period papers available from today's manufacturers.

On the same note, if you're trying to decide the proper way to treat your old house floor, *Floor Coverings For Historic Buildings*, by Helene Von Rosenstiel and Gail Caskey Winkler (1988, \$14.95) is an excellent guide. Spanning the years between 1750 and 1930, this book covers everything from plank and brick floors to linoleum and carpeting. Divided into five chronological sections, the text that

introduces each will give you a good understanding of the history at work here. This well-researched text is followed by a catalog of reproduction items and their manufacturers suitable for today's restorations.

If you're considering stencils as part of your wall treatment, Dover Publications, Inc. (New York, NY) publishes some excellent guides to the craft. For those interested in the history of the art and its place in the American decorative world, Janet Warings' *Early American Stencils On Walls And Furniture*, (1968; \$9.95) is interesting background reading. Dover also publishes a series of cut-and-use stencil books, including those with Victorian and Early American motifs.

Lighting and hardware

The last two books I want to mention deal with the finishing touches of your interior design work: lighting and hardware. Again, the Preservation Press publishes a useful guide for selecting the proper reproduction lighting fixtures. It's called *Lighting For Historic Buildings*, by Roger W. Moss (1988; \$13.95).

From candleholders found in the 1600s on through to the ceiling lights of this century, this book—like the other books I mentioned from the same publisher—can be used as a catalog by the old-house restorer. The text will help you decide which fixtures are appropriate for your old house, and list where to obtain reproductions and adaptations of period pieces. It's the best place I know of to start your search for period lighting.

Finally, in reviewing this column, I see that the balance of books deal with Victorian decoration. So, the last volume I'll mention here is one you early-American house lovers will appreciate. For those of you looking for appropriate hardware for our country's oldest homes, Albert H. Sonn's *Early American Wrought Iron: Three Volumes In One* (Bonanza Books, 1989; \$17.99) shows the work of the Colonial blacksmith. Many of its original designs can be recreated by those working this craft today (see "Restoration Hardware," page 42, June '90).

I hope this roundup of restoration books comes at a good time for many of you contemplating one or another of the projects they cover. As anyone who's done restoration work knows, having the right information at the proper time can mean the difference between an okay job and one that will enhance the period value of your home. I trust I've helped here with the latter. Happy reading! **PM**

BLIND TASTE TEST

(Continued from page 47)

in every test, exhibiting moderate power, decent handling and economy-car gas mileage comparable to the Corolla and Prizm.

This is the most dramatic instance in which our test results differ from Mr. Iacocca's theory. Our blind test group picked the Isuzu Impulse by 11 to 1, and our branded group preferred the Geo Storm by 9 to 3. There can be no doubt that the second group of testers was influenced by Chevrolet's Geo name on the hood.

Our blind group preferred the Isuzu's styling, calling it "smoother and sleeker" than Geo. They also preferred the interior and seats, which seemed more comfortable to them, and the instruments which were considered "more understandable" than those in Geo's Storm. They also liked the "sharp-looking" metallic blue paint on the Impulse.

Interestingly, the branded testers who preferred Geo's Storm had the same complaints about it as the blind testers who preferred Isuzu's Impulse. But they claimed that the Geo Storm had "better performance" and preferred its "simple, stripped quality" compared to the Isuzu's optioned-up complexity.

Both the Impulse and Storm were faulted by virtually every tester for their finger-pinching exterior door handle design. All our women testers also found the rear hatchback too heavy to lift and close easily. "It takes two hands—not easy when you have an armload of groceries." Both test groups also agreed that the Impulse and Storm seemed "chintzy, cheaply made and lightly built," and the driving was "bouncy, tiring and annoyingly noisy."

Test No. 5

In addition to their 4-wheel-drive versions, we compared the 2-wheel-drive models of the Mitsubishi Eclipse and Plymouth Laser, products of Diamond Star in Normal, Illinois. Both were identically equipped with the masterful turbo 2.0-liter and were even painted the same shade of red. Our blind testers couldn't tell the difference, splitting their vote 5 to 5 with two "no preference." Our branded testers, on the other hand, preferred the Plymouth version 8 to 3 with one "no preference." Once again, the badge on the hood seems to whisper, "Buy American."

Our amateur testers found the 2-wheel-drive Eclipse and Laser to be a handful under hard acceleration because of torque steer that's eliminated in the 4-wheel-drive version. As one shaken tester put it, "When the pow-

er is applied, I have the feeling the car, not the driver, is in control." Another man wrote, "Very fast, but feels unstable. Makes me nervous."

Otherwise, our testers had few criticisms about these well-made, high-performance machines. One of the main complaints about the Mitsubishi was its "sexy" rear spoiler, not fitted to the Plymouth. Most of the testers who preferred the Laser to the Eclipse mentioned the smoother lines without the "unnecessary wind foil."

Our women testers loved the image of the Eclipse/Laser. "Makes me feel like a cross between Barbie and Barbarella," enthused one. "If I was single," wrote another, "this would be the car for me. A sexy car that makes me sexy, too. That very image would make me buy it!"

Test No. 6

Suzuki and General Motors build the Sidekick and Geo Tracker in a joint-venture factory in Ingersoll, Ontario. We were unable to obtain two absolutely identical vehicles. Our Suzuki was a convertible, our Tracker a hard-top with an automatic transmission and, consequently, a higher price tag. We asked our testers to allow for these inconsistencies in their ratings.

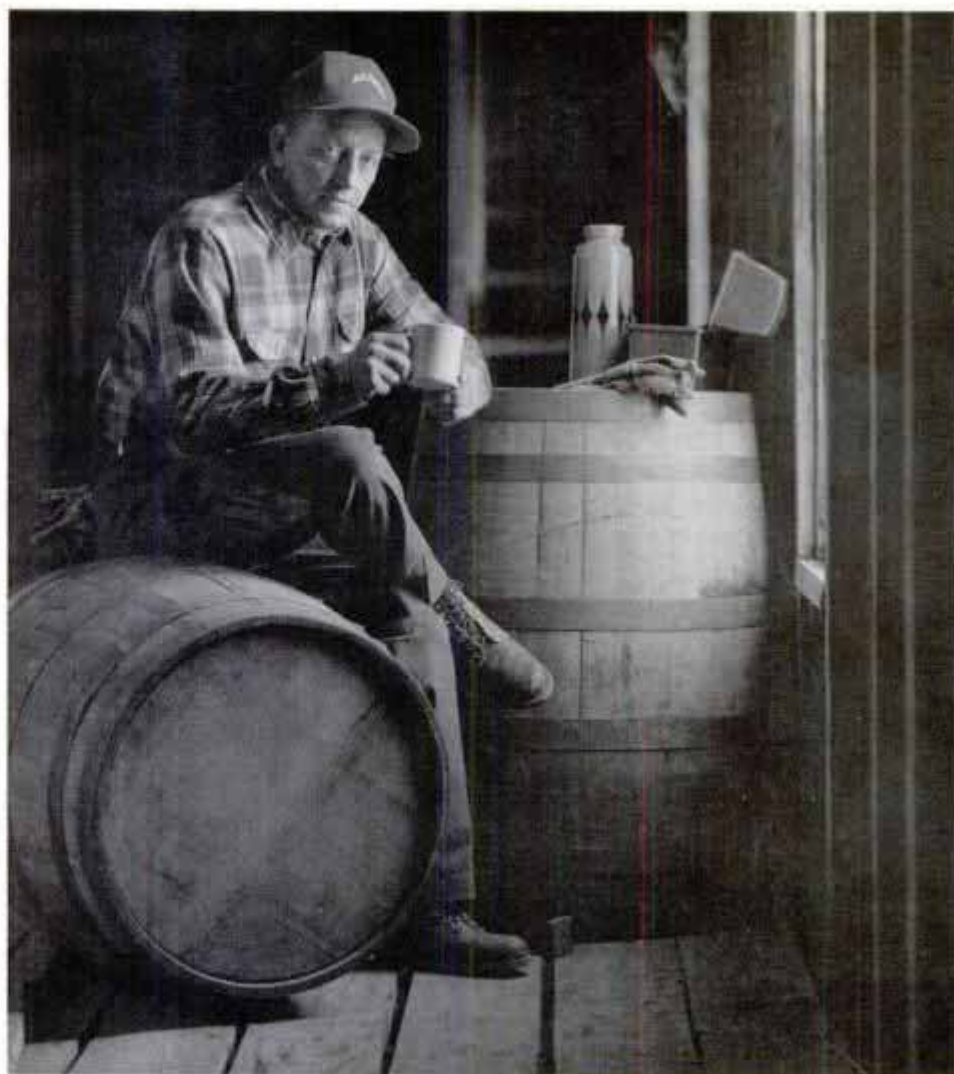
Whatever the reason, the Geo was chosen by our blind testers 6 to 2 with four "no preference," while the branded testers preferred it 7 to 5. Our testers were not particularly impressed by either trucklet, however, mostly because of the choppy ride, slow acceleration and "cheesy" construction throughout. A couple of testers "hated it," and one poetic type called it "an anchovy can on wooden wheels." A number of testers called it "dangerous," and as one tester queried, "Why make this thing at all?"

The lesson learned

We learned a lot of things from this test. Lee Iacocca is wrong. Americans are not sold on Japanese cars. Quite the opposite. They want to "Buy American," but Japanese manufacturers seem to offer more of the type of cars Americans need at a better price, and from more cooperative dealers.

American car buyers, at least the 24 testers we were privileged to work with for four days, are unbelievably knowledgeable and sophisticated when it comes to cars. We had room for only a fraction of their comments in this story, but if product planners from both Detroit and Japan had spent some time with us during our testing, they might have gone home with red faces and burning ears. But their cars would probably be built a lot better, too.

PM



We hope you'll stop by our old distillery if ever you're passing through Tennessee.

A TENNESSEE BARRELMAN like Richard McGee gets more done before coffee than most folks do in a day.

Mr. McGee will rise ahead of the sun. Then, in the cool of Tennessee's morning, roll hundreds of newly-filled barrels into aging houses set deep in the hills. (Our whiskey will sleep out here until it's ready for you). What accounts for the rareness you find in Jack Daniel's? Partly, this old Tennessee process. And, partly, old Tennessee barrelmen like Richard McGee.

SMOOTH SIPPIN'
TENNESSEE WHISKEY

Tennessee Whiskey • 40-43% alcohol by volume (80-86 proof) • Distilled and Bottled by Jack Daniel Distillery, Lem Motlow, Proprietor, Route 1, Lynchburg (Pop 361), Tennessee 37352
Placed in the National Register of Historic Places by the United States Government.



More muscle, less fat.

The new mid-size Dodge Dakota. Now with V-8 power.

More payload than standard Ford and Chevy half-tons.

Its agility approaches compacts. Its payload capacity holds its own against that of meatier half-tons. And with available V-8

power, it's the best all-around pickup on the road. It's the new mid-size Dodge Dakota.*



We revved up our Dakotas with a 170 HP V-8.

Dodge Dakota
4x4 Sport

Flexes new V-8 muscle.

To any skeptic who thinks Dakota's a dressed-up compact, take a look under the hood. There you'll find a choice of hard-working engines that no compact pickup can offer. Including a 3.9L V-6. And our 5.2L 170 hp V-8, turning out 262 lbs-ft of torque at 2,400 rpm.

Equipped for heavy loads.

If you want to see what a Dakota can

carry, fill it up with a load of topsoil. We've got up to 2,550 pounds of available payload, depending on engine and model. Standard Chevy and Ford half-tons can't haul as much. And though it's lighter than Chevy C1500, Dakota can carry 300 pounds *more*.** Not bad for a truck that's a lot leaner than its full-size competition.



Bodies of all sizes and shapes: 4x4, 4x2 and Club Cab.

The body you always wanted.

Take your pick of Dakotas. From 4x2, 4x4, longbed, shortbed, Club Cab

and Sport models. Every one has been restyled for 1991.

Welcome home to Dodge.

America is coming home to Dodge. And with trucks like Dakota V-8 and our full-size Cummins Diesel, the only turbo diesel pickup you can buy, we think they're home to stay. Come see what we're made of.

*Competitive claims based on '90 data ('91 competitive data incomplete at time of printing).
**Available regular cab 4x2 payload comparisons.

Buckle up for safety.



Advantage: Dodge.



CURING DRIVELINE VIBRATIONS

BY JOHN DECKER; PM Illustrations by Fred Wolff

● You climb in your car to go to work, just like you do every morning. After starting the engine, you immediately shift into Reverse and there's that noise again—a loud bell-like clank—as the transmission engages.

Actually, the noise is not transmission-related at all. What's more, it's not expensive or difficult to fix. Backing out of the driveway every day for a few years with a rapidly idling, stone-cold engine has simply pounded out one of the driveshaft universal joints. The noise sounds so expansive and expensive because rear-wheel drivelines can rival good ventriloquists in amplifying and then tossing sounds all over as they travel up and down the driveshaft.

A rear-wheel driveline's ability to throw sounds can give even seasoned mechanics nightmares—where loose torque converter-to-thrust-plate bolts mimic an engine rod knock, or a seemingly clunking rear suspension actually turns out to be worn splines on the transmission output shaft and driveshaft yoke.

Driveline diagnostics

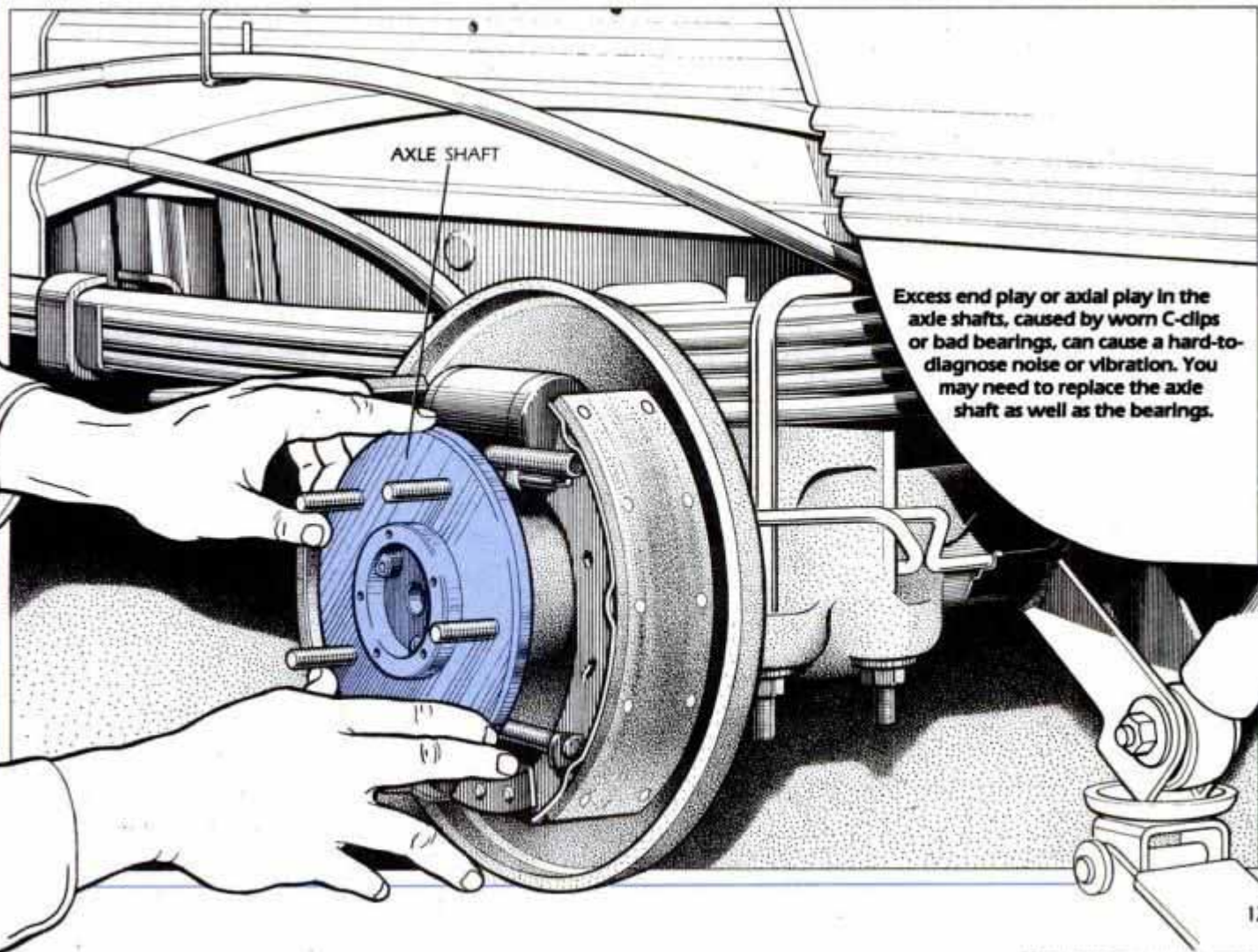
Consider any components—from the engine mounts all the way back to the road wheels—to be fair game when you're looking for mysterious driveline sounds or vibrations.

Many driveline noises tend to change in frequency, pitch or speed. If the noise change is dependent on

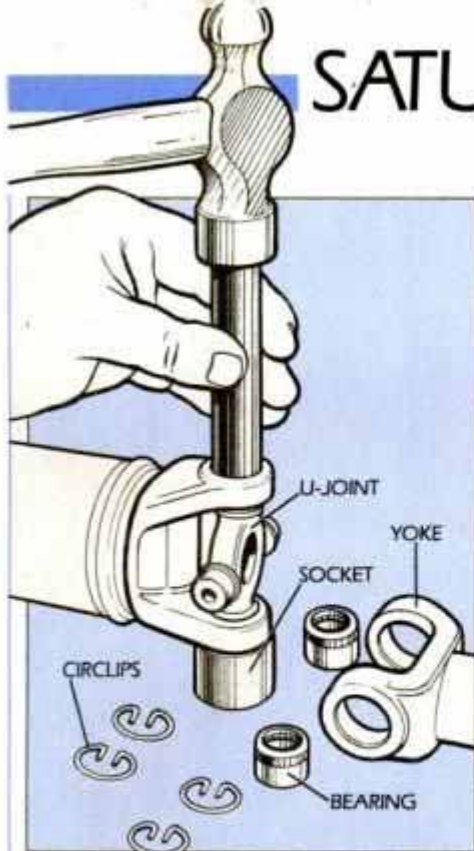
engine speed, it means the noise is most likely engine-related. If the noise occurs in some gears and not others, look for transmission problems. If the noise changes according to vehicle speed, you'll probably find its cause somewhere between the transmission output shaft and the rear wheels.

Clunks, clanks, bangs and bongs usually occur during acceleration or deceleration and most often relate to excessive wear or play in a driveline part. To check out these noises, drive the car on smooth pavement at varying speeds, being sure to make several left and right turns.

With automatic-transmission cars, engage and disengage the transmis-



Excess end play or axial play in the axle shafts, caused by worn C-clips or bad bearings, can cause a hard-to-diagnose noise or vibration. You may need to replace the axle shaft as well as the bearings.



Use an old wrist pin and socket to lightly drive out old U-joint bearings.

sion while the car is stopped and note whether you hear bangs or clunks shifting into Drive or Reverse.

If you hear driveline noise in manual transmission cars only when the clutch pedal is depressed, suspect a bad throwout bearing.

As you drive, shift to Neutral and let the engine idle. If the noise disappears, it's most likely engine related.

Getting your bearings straight

If you hear a whirring or a grinding noise from the rear of the car, and the noise changes in frequency or volume when making turns, the cause is most likely a rear-axle bearing.

To change a rear-axle bearing, you have to remove the axle from the housing. The most common methods of holding an axle in the housing are with a C-shaped retainer inside the differential, or with a bolt-on flange at the outer end of the axle housing.

To remove axles with a C-shaped retainer first, drain the gear oil and remove the differential cover. Next, remove the differential pinion shaft and pinion gears to gain access to the retainer. You'll see the C-shaped retainer on the end of the axle shaft where it fits into the differential side gear. With the differential pinion gears removed, there is just enough room to push in the axle sufficiently to allow the C-shaped retainer to be pulled out. Once the retainer is out, the axle slides from the housing.

Unfortunately, the axle also acts as the inner race for the bearing. That

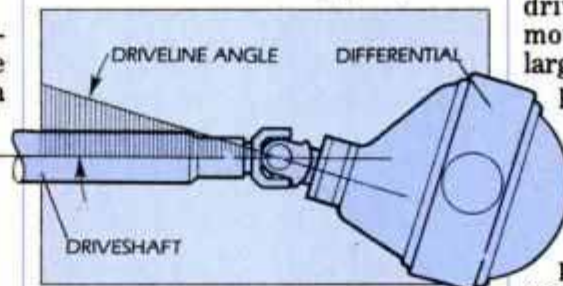
means if the bearing is bad, the axle's bearing surface is probably pitted, galled or grooved, and both the bearing and the axle must be replaced.

To remove axles that are held with a bolt-on flange, simply remove the fasteners holding the flange to the housing and attach a slide-hammer puller to the lugnut studs on the end of the axle. After a few tugs on the slide hammer, the axle and bearing should pop out of the housing. A pressed-on retainer holds the bearing onto the axle, but most automotive machine shops will remove the old bearing and retainer and press on new parts. And always replace bearing seals when changing a bearing.

Peek underneath

Once you've noted any noises during your road test, it's time to crawl underneath for a closer inspection.

Begin by checking the tires. Abnormal tire wear, such as cupping or signs of obvious imbalance, can cause driveline noise. This is also a good time to look for roadway parapherna-



Vibration under load may be U-joints binding at excessive driveline angles.

lia, such as wire, string or rope, that may have wrapped itself around the driveshaft.

U-joint points

The most common cause of rear-wheel driveline noises are worn or damaged U-joints. To check, set the parking brake, then firmly grasp the driveshaft near the rear U-joint. Any side-to-side or up-and-down movement in the joint indicates excessive wear or failure in the U-joint bearings.

Other than the stone-cold backup syndrome mentioned earlier, U-joints usually fail after the seals holding the lubrication in the needle bearing cups fail. Once the seals let go, the grease quickly flies out and the needle bearings fail. It's easy to tell when a seal has failed because there is a telltale line of grease on the floor pan inline with the failed joint.

U-joints can also bind, which can cause noise or imbalance of the drive-



Lightly tapping a frozen U-joint may free it temporarily.

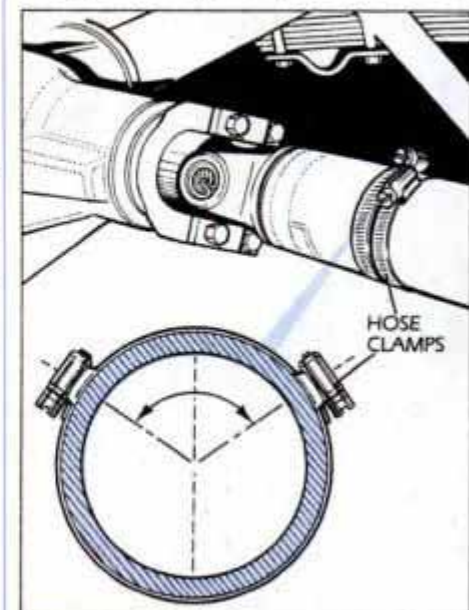
shaft. Sometimes, tapping the U-joint with a soft-faced hammer will loosen a binding U-joint and the problem will disappear. If so, the U-joint should be removed and inspected, then replaced or relubricated.

Removing and installing universal joints is not difficult. After removing the driveshaft, remove the clips that retain the U-joint bearing cup into the driveshaft yoke, propeller shaft or mounting flange. Using a press or large diameter punch and hammer to push on one cup will push the other cup out on the opposite side.

To install a U-joint, press the new cups in place after the U-joint spider is installed in the driveshaft. If you don't have a press, auto machine shops will also replace U-joints.

Bad vibrations

Vibration or imbalance problems that change with engine speed are usually



Rebalance a driveshaft on the car by systematically adding weight with hose clamps.

confined to the torque converter on automatic transmissions, or the clutch and flywheel on manual transmissions. Balance problems that occur after the transmission output shaft are vehicle-speed sensitive and,

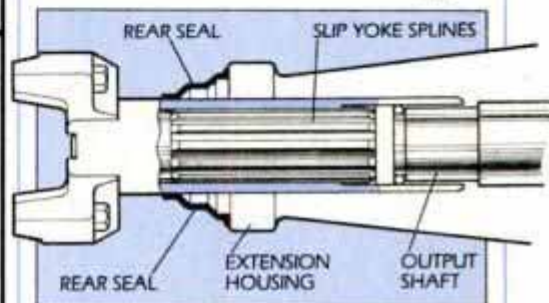
aside from tire imbalance, can usually be traced to the driveshaft.

It's not difficult to distinguish between driveshaft and tire imbalance. Because the driveshaft spins ahead of the differential, it rotates 2.5 to 3.5

times faster than the tires do—with a corresponding difference in the frequency of the imbalance. You'll also feel driveshaft imbalance more in the seat and floor pan, because the vibrations don't have to travel up through the suspension springs before reaching the body and interior.

A driveshaft that is dented, bent or missing its balance weight (usually located near the rear U-joint) causes driveshaft imbalance. You should also inspect the companion flange on the differential. If a U-joint lug has sheared off, the U-joint can ride off-center, causing imbalance.

Removing and replacing the driveshaft without returning it to its original location can also cause driveshaft imbalance. For this reason, you



Thumping noises may emanate from a dry or worn set of output shaft splines.

should always mark the driveshaft with chalk and make a corresponding mark on the differential companion flange, so you can return the driveshaft to the same position. You should also mark a clutch, pressure plate and torque converter before removing them for the same reason.

Sometimes you can cure driveshaft imbalance problems by simply rotating the driveshaft's location in the differential companion flange. Try rotating it one-quarter turn at a time to see if the imbalance goes away. If that doesn't work, mount two large hose clamps around the driveshaft near the differential end. The screws on the clamps will act as balance weights. Start with the screws opposite each other and gradually rotate the clamps so the screws get closer together and the imbalance disappears. If rotating the screws to one side of the shaft doesn't work, try rotating them to the other side. Failing that, many automotive machine shops and frame shops have the ability to balance driveshafts off the car.

Thump-bump in the night

As the rear suspension moves up and down, the driveshaft swings in an arc. This means the driveshaft must get

CAUSES OF DRIVELINE PROBLEMS

Speed (MPH)

0 10 20 30 40 50 60 70

Speed (MPH)	0	10	20	30	40	50	60	70	
Engine Mounts Loose Or Damaged	←→		←→						Engine Speed Sensitive
Engine Accessories Loose Or Broken	←→		←→						
Engine Accessory Drive Belts Loose Or Worn	←→		←→						
Universal Joints Brinelled Or Galled Due To High Loads Or Improper Lubrication				←→		←→			Vehicle Speed Sensitive
Undercoating On Driveshaft, Imbalance, Excessive Runout				←→		←→			
Universal-Joint Angles Incorrect	←→			←→		←→			
Uneven Tire Wear				←→		←→			
Tire Or Wheel Radial Runout			←→		←→				
Tire Or Wheel Lateral Runout						←→			
Tire Balance				←→		←→			
Wheel Bearing	←→					←→			
Worn CV Joint						←→			
Worn Rear Axle Bearings Or Gears			←→		←→				
Worn Transmission Extension Housing Bushing				←→		←→			
Universal-Joint Wear	←→			←→		←→			
Universal-Joint Angles Incorrect	←→								
Rear Chassis Parts Loose Or Worn	←→		←→						
CV Joint Worn Or Damaged	←→								
Noise And Vibration	←→		←→		←→		←→		Acceleration Deceleration Sensitive
Vibration Alone	←→		←→		←→		←→		

shorter and longer as it travels through the arc. For this reason, the front of the shaft is usually splined and it slides into corresponding splines on the transmission tailshaft. A thump-bump sound can occur when going over bumps that can be traced to these splines. If the splines get dry, they bind as the driveshaft gets longer and shorter. Eventually, a step wears into the splines, and the result is a thump-bump as the driveshaft moves in and out.

To inspect the splines, remove the driveshaft, then look at the splines inside the driveshaft yoke and on the transmission output shaft. The step is usually found on the yoke. The only cure is to replace it. Far more serious are stepped splines on the output shaft, because the transmission will have to be disassembled and the output shaft replaced.

Differential equations

If you hear clunks—especially around corners—and the U-joints are okay, the problem may be excessive axle end play. To check for excessive end play, simply jack up the car and pull in and out on the rear wheel. If the axles are held into the axle housing with C-shaped retainers, the retainers or the groove in the axle may be worn and end play is the result. On Fords, you can reduce end play by putting shims behind the C-shaped retainers. On GM cars, you'll have to replace the axle, the retainer, or both.

Chuckles, chatters, ticks, clicks, whines and whistles can all get their start in the differential. Chuckles and chatters can occur if the differential gear lube is low, or on limited-slip differentials, if the wrong gear lube is in-

stalled. Chatters can also occur if the differential (spider) gears are assembled too tightly. You'll also get chattering if the differential's limited-slip shim packs are too tight.

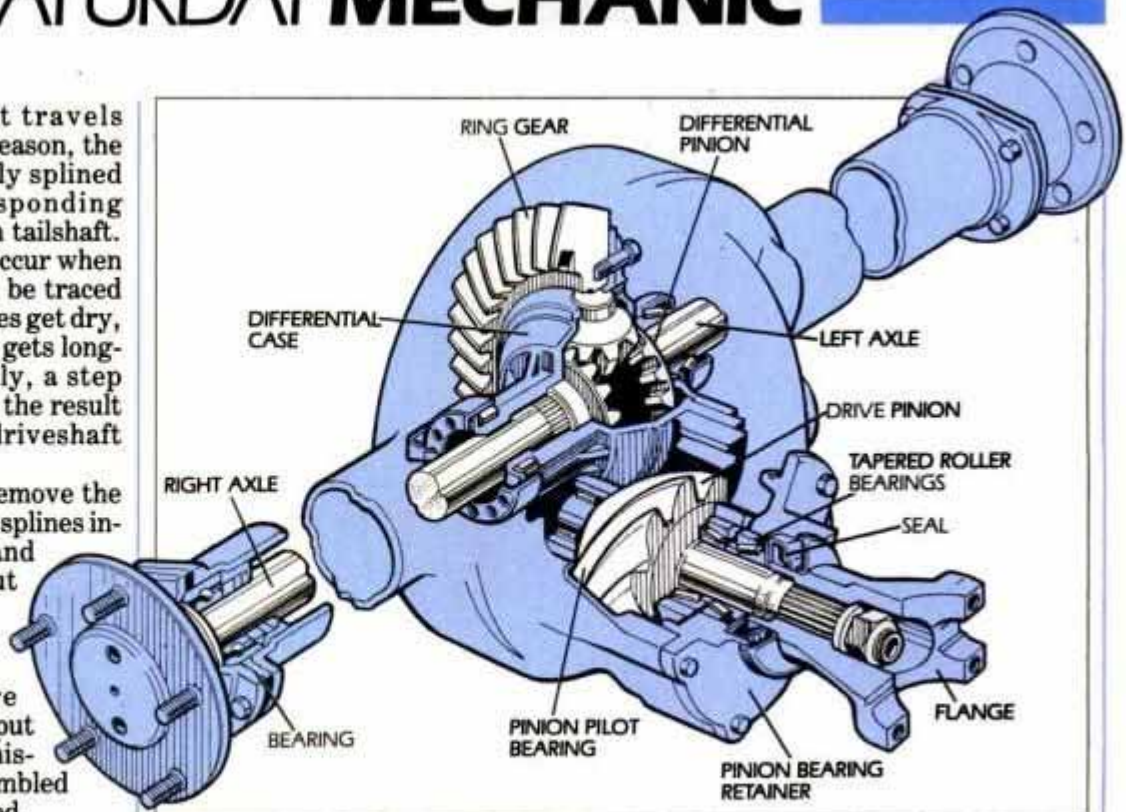
Differential whine can be traced to a few causes. Many ring and pinion gearsets are "timed" so each gear tooth on the ring meshes with a corresponding tooth on the pinion. If they don't, the result is whine. To check timing, remove the differential cover and look for witness marks on the pinion and ring gear. When you rotate the gears, the marks should align.

Other causes of whine are incorrect pinion bearing preload, an improper wear pattern on the ring and pinion gearset or improper differential bearing spread. All of these problems

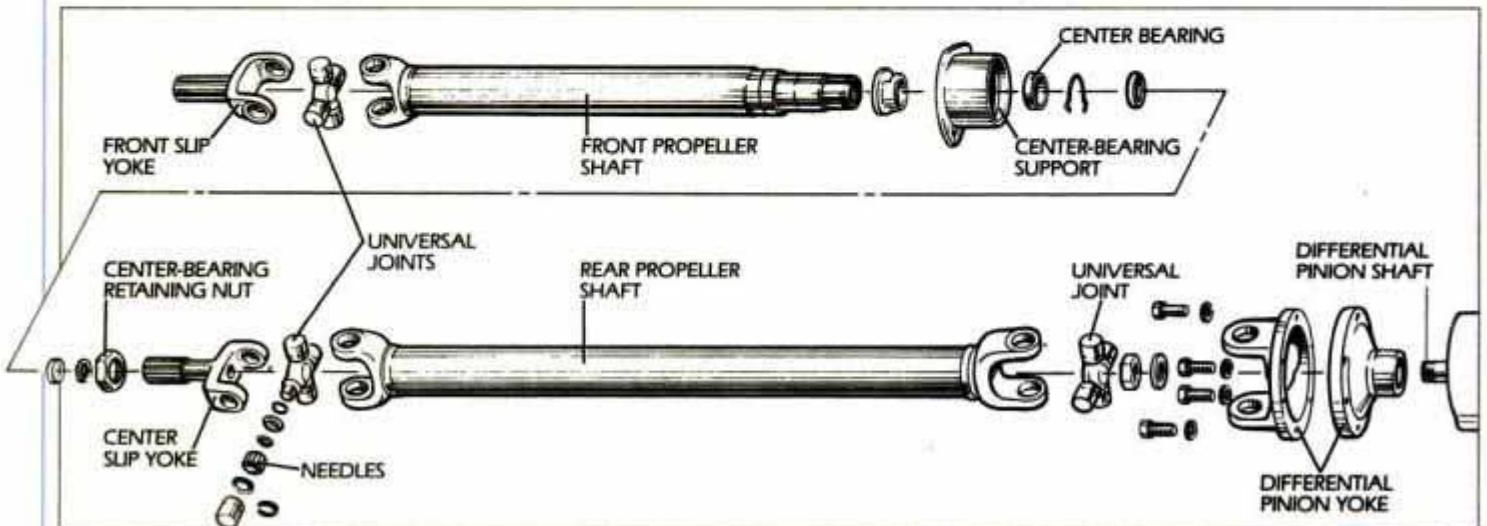
should be checked and repaired by a qualified differential specialist.

One source of whine—usually loudest in the passenger compartment—can come from the middle of the driveshaft on some cars, such as early GM models and many Volvos. Because these cars have a 2-piece driveshaft, the front half is supported by a bearing that's mounted around the driveshaft.

To check the center support bearing, remove the driveshaft (you'll usually have to remove the bearing mounting bolts to do this). Rotate the bearing to see that it operates smoothly and freely, with no noise. The rubber isolator between the bearing and its mount should also be free of play and cracks.



Noisy differentials may require partial disassembly to diagnose some problems.



Some larger vehicles use a 2-piece driveshaft with a center bearing and a third universal joint.

ELECTRONICS

BY FRANK VIZARD, Electronics Editor



TV From Space Made Easy

● Getting television directly into your home from orbiting satellites is a notion that only the most jaded doesn't find exciting. While home satellite systems didn't sell in droves the way many initially thought, satellite TV is making a comeback.

The main thing you have to accept is that good programming isn't free. Many satellite television signals were scrambled in 1986, and at this point, programming charges are comparable to those for cable TV. You're still required to buy your own hardware, but for those outside the reach of both cable and broadcast TV, there's no other way to access the 130 channels available through satellite TV.

Satellite TV systems are more attractive than in years past simply because they are now easier to operate. Programming subscriptions are centrally handled by General Instrument Corporation, and you'll need one of the company's VideoCipher II Plus decoders to view scrambled satellite signals. These decoders are built into integrated receiver/decoders (IRD), like the Toshiba TRX-2000 pictured here. The TRX-2000 lists for \$1949. You can expect to pay between \$2500 and \$4000 for an overall system that would include a dish antenna, installation and relevant hardware.

IRDs are now so easy to use that machines like Uniden's UST-4800

have the reputation of being idiot-proof. Part of the reason is the inclusion of a service called SuperGuide. This guide to what's on is downloaded via satellite to the IRD once a day to continually keep you informed of the programming available for the next 12 days. SuperGuide is free the first year and \$40 each year thereafter. List price for the UST-4800 is \$2195.

R.L. Drake's ESR-1424 IRD (\$1689) includes an automatic satellite locator that can track both low power C-band and higher power Ku-band "birds" automatically. Once the east/west limits are entered into the IRD by the dealer, the locator does the rest at the touch of a button.

Terrestrial interference (TI) from other microwave transmissions is still a problem relative to C-band transmissions. IRDs like Chaparral's Monterey 90 (\$2500) have programmable TI filters that can be assigned to clear up troublesome channels. The TI filters are aided by a video noise-reduction system that narrows the "window" open to the incoming signal, hoping to shut out the interference in the process.

Downsized dishes

Less of a problem is the aesthetic objections neighbors may have to the sight of an 8- to 12-ft. in diameter dish needed to receive weak C-band transmissions. A Federal Communications Commission ruling prohibits discrimination against satellite dishes in zoning ordinances. An information package on this subject is available for \$40 from the American Home Satellite Association. Call (800) 321-2472 for more information.

Large dishes may already be on the

road to obsolescence. At least one or two direct broadcast satellite (DBS) television services are scheduled to debut early next year.

By using a high-power Ku-band satellite, SkyPix Corporation of Kent, Washington, is able to limit dish size to between 22 and 36 in., depending on the geographic location. List price for the dish and receiver is \$699.

Thanks to video compression techniques, SkyPix says it will be able to offer a tremendous amount of channels while only using a single satellite. SkyPix plans to offer 80 channels initially, but up to 250 channels can be allegedly accommodated. Both the video and audio signals will be transmitted digitally so the picture should be devoid of ghosting, color smearing and "snow."

Billing will be done on what's essentially a pay-per-view basis. Subscribers would establish a monthly credit line using a major credit card. As you use the service, a fee will be charged against your account.

Competition to SkyPix is expected from K-Prime, a joint venture involving General Electric and nine cable TV operators.

Dish size is tentatively set at 45 in. in diameter since K-Prime is also using a Ku-band satellite. K-Prime will offer a 10-channel package that includes seven superstations and three pay-per-view channels. The monthly fee would be between \$20 and \$30, says the company.

Sky Cable, another DBS venture, is scheduled to get off the ground sometime in 1994. If successful, these DBS projects may be a harbinger to the disappearance of larger satellite dishes.

FM

AVIATION

BY FRED MACKERODT, Contributing Editor



PHOTO BY ALLEWANT

The Plane That Wrote History

● There are only a few machines that have dramatically and emphatically changed the course of history. And I'm not talking about evolutionary changes that take place over the course of years, like those brought about by the automobile and the telephone and the transistor and even the fax machine.

Recently, I was given the opportunity to fly one of these machines—the Vickers Supermarine Spitfire.

The Spitfire changed history in just a few short months. If it weren't for this plane and the valiant young men who flew it, Adolph Hitler could very possibly have bombed Great Britain into submission and gone on to fulfill his warped dream of world domination in those dark months of 1940. Where that would have left us today, a half-century later, is anybody's guess.

Spitfires over New Jersey

My chance to pilot one of the 20 still-flying Spitfires of the 20,000 odd airplanes of their marque built came about as part of the commemoration in the United States of the 50th anniversary of the Battle of Britain.

Jaguar, the car company, decided to stage the commemoration at the yearly Experimental Aircraft Association get-together in Oshkosh, Wisconsin. As part of the memorial, Jaguar assembled a group of airplanes of that era: a Hawker Hurricane, a deHavilland Mosquito bomber, a Messerschmitt Bf 109 and two Spitfires. The Oshkosh exhibit was created by Dr. Michael Fopp, director of the RAF Museum in Hendon, England, and the acknowledged expert on the Battle of Britain. Jaguar brought Dr. Fopp and one of the Spitfires—owned by Bill Greenwood, a 46-year-old investor from Aspen, Colorado—to my home drome, Essex County Airport in Caldwell, New Jersey, and offered yours truly the chance to fly it from the back seat.

The back seat? The Spitfire was a single-seat fighter. In the early days of World War II, the training procedure was to let a prospective young pilot accumulate some hours in a lesser 2-seat airplane with an instructor, and then, with a prayer and a few quick pointers, buckle him into the Spitfire and send him on his way. If the young pilot came back from his

first solo flight, that was taken as a good sign and he was promptly dispatched into combat. This training procedure accounted for the fact that many more warbirds were lost in training than in combat.

Greenwood's airplane was originally built in 1945 as a single seater. But after the war, and with the luxury of time, the front cockpit was moved forward 13 in., and a second cockpit with dual controls and full instrumentation was added in the rear for an instructor, making for much more civilized training. It was used in this configuration by the Irish Air Force until 1961.

Best of the breed

The Spitfire was built in 40 flavors, and Greenwood's plane is the Mark IX version, considered by many experts to be the best. Earlier versions lacked the performance, and later Spitfires had quirks said to outweigh their "improvements." It is powered by a Rolls-Royce Merlin engine, rated 2050 horsepower. With a unique 2-stage supercharger, the second stage of which kicks in with a bang at 16,000 ft., the engine is a liquid-cooled 12-cylinder. The airplane is capable of 4000-ft.-per-minute climbs and has a ceiling of 43,000 ft. According to

Greenwood, a Mustang can't keep up with the Spit in a climb, and the only contemporary plane that will beat it up to altitude is the Bearcat. The quick climb enabled it to scramble quickly into position when German bombers and its main adversaries, the Bf 109 and Fw 190, were detected coming inbound from the French coast.

Maneuverability in a dogfight was the Spitfire's forte, according to Greenwood. "It will come around tighter than a Mustang, and about the only plane that could outturn it was the Japanese Zero."

The airplane was primarily a defensive aircraft, with a limited range. With fuel consumption going from a low of 30 gallons per hour, to a high of 150 gallons per hour at combat power (which was permissible for only 5 minutes), the Spitfire had operation and endurance in most cases of well under an hour without supplementary fuel. Top speed in level flight ranged up to 450 mph, and the airplane could dive at .88 Mach.

Greenwood typically flies his airplane at 210 knots in cruise and 250 knots "when playing around." He tries not to push it, what with an engine overhaul going for \$45,000. He hopes with some luck to get 1000 hours out of his current engine.

That sinking feeling

My chance to fly Greenwood's Spitfire came one Monday morning last August. I almost drooled as I walked out on the tarmac and approached the beautiful warbird, all 31 ft. and 6000 pounds of it. All hyped up and with parachute attached, I nervously climbed up on the aircraft with Greenwood issuing instructions. Seeing the Spitfire sink under my substantial frame, Greenwood asked, "By the way, how much do you weigh?"

"Oh, 220 pounds or so," I said, sucking in my stomach. My quick esti-



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mate was actually about 10 pounds lean of reality.

"Sorry," Greenwood said, "I can only take a maximum of 190 pounds in the rear cockpit." I was shocked. It was one thing to be born too late for the war, but another to be too fat.

Back on the ground and crestfallen, I listened as Greenwood explained that with a rear center of gravity, the airplane gets squirrely on landing. After all, the Spitfire wasn't originally designed to carry that kind of weight that far back. Although everything would probably be okay, he

doesn't like to take any chances with his pride and joy. With an aircraft valued at \$750,000, I couldn't blame him.

Mike Dale, the Jaguar executive who dreamed up the whole deal, replaced me in the cockpit. Dale is considerably slimmer than I, though not nearly as good looking.

God's gift to pilots

After the flight, I talked to Mike about the plane's performance, when he finally managed to stop smiling and could talk coherently. The owner of an open-cockpit Stearman, Dale said the Spitfire flew "better than I had ever dreamed. In slow flight, it's controllable down to 75 knots, which is quite remarkable for an airplane of its performance. The rudder is also quite powerful and very sensitive. It is safe, smooth, enormously powerful and eminently controllable. With a flick of the stick, the plane will spin right around its big, 4-bladed propeller. It's God's gift to pilots." I stood there with my tongue hanging out.

At the end of the day, I asked Bill Greenwood whether he intended to be at Oshkosh in 1991. He answered affirmatively.

I left the airport that day with Spitfires on the brain and a diet on my agenda.



Grounded editor gets as close to flying the Spitfire as his size will allow.

PHOTO BY AL LEWANT

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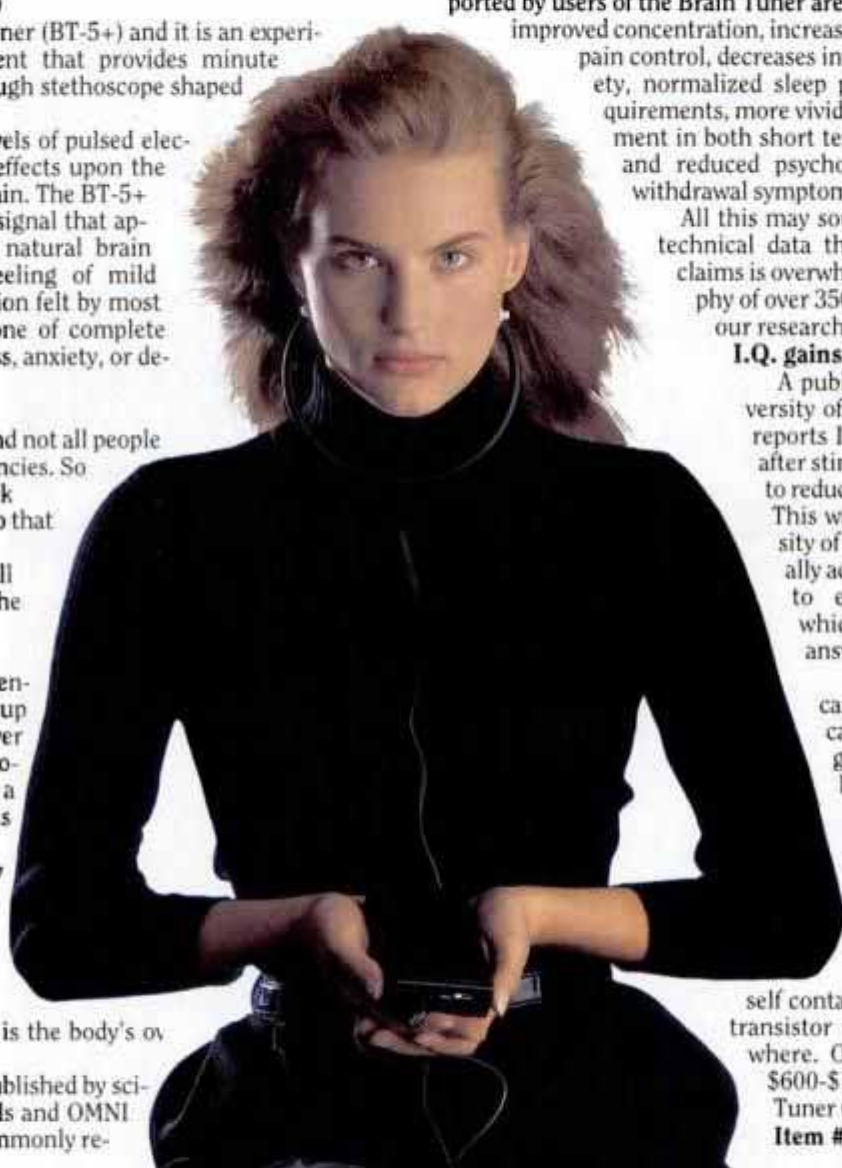
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DRIVE REPORT

BY MIKE ALLEN, Assistant Automotive Editor



GM Saturn Revisited

● Following the Saturn story over the past few years always has been sort of reminiscent of the story of the emperor's new clothes, with the rest of the world looking hard to see Roger Smith's vision of what a modern car company ought to be organized like—and what kind of car it might build. There's been a lot of speculation, a lot of Jim Dunne's spy photos, and a lot of misinformation. Saturn is coming to market, finally.

Saturn Corporation has come from Smith's miasmic vision to the status of a contender in about the same length of time Detroit used to take to implement a major model change. It's been a rocky road, with management changes, downscaling of plans, rethinking of the particular market niche to conquer first and inventing an entirely new technology of manufacturing automobiles.

And finally, we've been able to actually drive and test a production-line-built Saturn, first privately at and around the General Motors proving grounds in Milford, Michigan, and a few weeks later on the grounds of the factory complex in Spring Hill, Tennessee.

Starting from scratch

Consider the monumental task facing the new management at Saturn. They had no engineering staff, no factory,

no office buildings and a moving target in their mandated small-car market. A market that was then, and is now, filled with competent, aggressive competitors. There would be no room for mistakes. They had the advantage of not having to deal with the bureaucratic inertia of General Motors and still being able to use some of GM's vast resources.



Saturn's dashboard is plain, but control placement is well thought out.

The new factory in Spring Hill uses the latest in lost-foam casting techniques to manufacture engine blocks and heads from aluminum and crankshafts from iron. The fenders and door skins are injection molded on-site from recyclable thermoplastics, unlike the Pontiac Fiero and General Motors minivans made from thermoset sheet-molding compound. The space-frame chassis is stamped and

fabricated on-site, and it's claimed to be one of the most dimensionally accurate chassis ever mass-produced.

In fact, virtually all of the Saturn is fabricated and assembled on-site at Spring Hill, a concept of car manufacturing that goes back to the days of Henry Ford.

Our last coverage of Saturn was in hand-assembled, prototype vehicles. As is often the case, real production-line vehicles are often substantially improved over the prototypes. From simple things like the interior colors all matching, to more subtle nuances in ride and handling, we're used to seeing improvements over the months of production-line "tuning." Saturn is no exception.

Start with the paint. Because of emissions regulations, the paint uses water instead of hydrocarbon-based solvents. And the finish is as good as any in the industry, on any car at any price. Totally devoid of orange peel, it's as glossy and as flawless as a pane of glass. We weren't given a tour of the paint shop—there's some proprietary technology in getting a good, consistent finish on the thermoplastic-and-sheetmetal bodywork. How well waterborne paints hold up farther on down the pike remains to be seen, but at least the plastic panels won't ever rust.

The interior is plainly but tastefully done with much attention to detail, and seems spacious for a car in this

class. Exterior styling you'll have to decide on for yourself, but at least the badging is very subtle, with the Saturn logo in the rear bumper in low relief and a single small badge positioned on the hood.

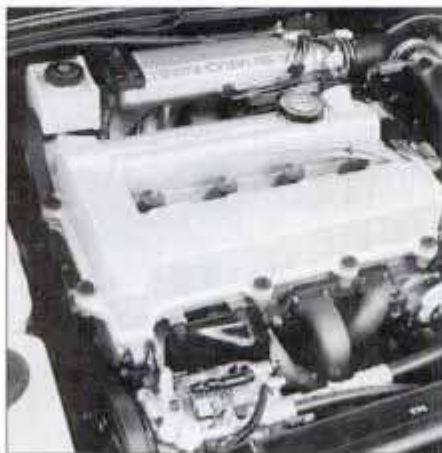
Exterior fit and finish are equally as good. Because the thermoplastic panels grow more in the hot sun, the gaps in the door seams are slightly wider than a steel-paneled car. But the gaps are true and consistent. The rear window glass has a deep compound curve and flush mounting, made possible by the tight dimensional accuracy of the bodywork. It's certainly tight and squeak-free.

Driving Miss Daisy

Rural Michigan and Tennessee have good roads, light traffic and beautiful summer scenery in common. And occasionally, Saturns are seen wandering about, although the badges are covered up anytime the vehicles are off General Motors property.

After a few hours of testing on the Black Lake at GM's Milford Proving Grounds (see data in Test Results chart, next column) we drove for a few hours—to Hell (a small town in southern Michigan) and back. Test results put Saturn in the ballpark, performance-wise, with Honda, Mazda and Toyota.

There are two engines: a 95-horsepower sohc 2-valver and a 123-horsepower dohc 4-valver. Built on the same 1.9-liter sleeved aluminum-alloy block, they are cast, machined and assembled on the same production lines, allowing for instantaneous changeover from one to another, depending on the vehicle being ordered. There's a 4-speed automatic and a 5-speed manual. Both are also built inter-



Single- and dual-cam engines are manufactured on a common production line.

TEST RESULTS		
	BASIC SEDAN	COUPE
Slalom	58.1 mph	57 mph
Skidpad	.75 G	.84 G
Acceleration 0-60	10.79 sec.	8.84 sec.
Acceleration ¼ mile	16.60/	18.01/
	84.4 mph	77 mph
Braking 60-0	142 ft.	135 ft.

changeably on the same production line. This arrangement is unique in the domestic automotive industry.

There's adequate power, even with the base engine and automatic. The 5-speed twin-cam is downright fun, although it does seem a trifle sewing-machine-like in character. Again, in the market segment, Saturn is right on target.

Driving qualities are fine. PM's Automotive Editor Tony Swan complained about understeer driving the prototypes (see "Saturn Story," page 38, Oct. '90). That's been improved, and skidpad testing reveals a mild, controllable understeer with power, characteristic of front-wheel-drive cars, and by no means a problem.

Testing

That's not a misprint in the specifications box (refer to Test Results chart). The base-suspended car, with narrower tires, is just marginally faster than the performance version in the slalom. We repeated the slalom a number of times with similar test results. We've seen this before on cars with wide, low-profile tires—the vehicle rolls over far enough during violent maneuvering to lift the inside of the flat tread off the pavement and reduce the available adhesion. Narrower tires remain in contact full-time. In spite of this, the suspension is tight and sharp, although driven back-to-back with a Honda, perhaps a bit harsher and, at the same time, more precise.

Braking performance is average, either with the base disc/drums or the optional 4-wheel discs. We strongly recommend the optional ABS system—a welcome safety addition not usually found on vehicles in the \$10,000 econobox market segment. It's GM's new low-cost ABS VI, and its performance is as good as any of the more expensive systems.

Saturn rising

Saturn's corporate culture is fresh, the factory is new and intended to blend into the gentle Tennessee countryside, and relationships with the United Auto Workers union are better than ever.

None of that means anything to a potential import car buyer who wanders into a new Saturn showroom this fall looking for an alternative to a car from the Orient. What does matter is the vehicle—and plenty of buyers are going to find Saturn to be just fine. We certainly did. **PM**



Saturn Corporation's model lineup includes (left to right): a 2+2 coupe, a plain-Jane 4-door and a more luxurious sedan.

COASTAL RUN

(Continued from page 63)

us as we ride with giant freighters and cruise ships into New York Harbor and pass the Statue of Liberty.

I'd planned on throwing John overboard at our final marina on the Hudson River, but decided against it after looking at what passes here for water. My big fear was that he'd pull me in with him. Instead, John and I sit at a dockside bar until nightfall and watch the Manhattan skyline come alive with glittering lights.

Torture test

The torture part of this torture test doesn't apply to the Larson boat or Johnson engines. The equipment performed sensationally. I can't say the same for the crew.

There were times when I doubted my seaworthiness, but never the boat's. The Larson 228 (base price \$17,135) is an offshore fishing rig that's built as tough as they come. Nature threw everything she had at us, and the Larson took it in stride.

The boat's Delta Conic hull, which begins with 30° of deadrise forward and tapers to 14° aft, enables the craft to quickly leap on plane, even loaded down with 1000 pounds of gear.

Despite its compact size, the sporty, low-slung Larson has a 6-ft. V-berth below and a roomy cockpit above. Maintenance is easy because teak is eliminated and a saltwater washdown faucet is standard. Features we especially like are an aft pedestal mount that enables the passenger seat to become a fighting chair, a built-in tackle box below, running fresh water, large insulated storage boxes, generous space in front of the windscreen to spread out charts and mount instruments, and excellent access to oil tanks.

The twin Johnson 120s also took the journey in stride. A faulty starter forced us to use a pull-cord several times, but it eventually fixed itself. Then we plugged a water intake after hitting a plank in the Hudson River, where enough lumber was floating to build a house. This enabled us to try running on one engine and, to our surprise, the boat nimbly got up on plane. Overall, we ran the engines as fast as conditions allowed for a total of 1500 miles and 85 hours. We burned 1080 gallons of gas and 23 gallons of oil. At first, we babied the boat and motors. But, as we successfully met each of the daily challenges, we came to feel we could trust our lives with the rig.

Our trip up the long blue highway took us from the glitz of "Miami Vice" to the mean streets of New York. In between, it gave us a megadose of what many consider to be the loveliest scenery on the continent. **PM**

LONG-TERM TEST CARS (Continued from page 59)

is? At 4900 miles, the message center lit up with CHANGE OIL. That seemed a little early to us, since the owner's manual recommends 7500-mile oil-change intervals under normal usage. But then a Cadillac engineer explained that the computer senses actual operating conditions and then triggers an earlier oil-change interval if the car was driven hard or under severe conditions.

We dutifully had the oil changed as recommended by the car's computer, and at the same time, had the dealer repair the electric lock system, which had blown a fuse. Driving the Seville thereafter was lots of fun, but uneventful. The car has just passed the 8000-mile mark. —Joe Oldham

Eagle Talon TSi

After 12,000 miles of cross-country and commuting service, it's time to turn in our Talon, and we're genuinely sad to see this one go.

Strong point: an incredible propensity to make mass quantities of real estate disappear in the rearview mirror, rain or shine. Coupled with the leather interior, CD player and girl-catching good looks, what really impressed us was its ability to handily dispose of V8 poneycars.

Carving up traffic is lots of fun, too—although you have to be aware that it takes a second or two for the turbo to catch up with your right foot. With four wheels driving full time, there's never a worry about spinning a tire or sliding the back end into a taxicab part way around a corner.

The only disappointment has been mediocre gas mileage—never better than 22 mpg on the freeway with the cruise set, and dipping to 15 in Manhattan's gridlock with the a/c and the CD both wide open.

The driver's-side door gasket had to be glued back into place, merely a minor annoyance, fixed in seconds with some weatherstrip adhesive. Of more concern was a minor but noticeable out-of-true condition in the brakes somewhere, making the car sort of shake its head slightly as it came to a stop. It certainly did little to the effectiveness of the brakes, which were good enough to require a look in the rearview mirror before any serious braking—few cars can decelerate this hard.

We didn't like the spare tire taking up most of the trunk, pushed there by the rear differential's presence immediately below the trunk floor—and right where the spare fits on the fwd version. Couple that with the goofy hardboard trunk cover, and there's no room at the inn for luggage. We simply used the removable trunk cover

for something else, and left the rear seats folded down to make room enough for groceries. —Mike Allen

Mazda MPV

It's hard to believe, but our MPV has racked up over 22,000 miles without a single mechanical flaw.

The MPV's long suit is carrying a bunch of people along with a fair amount of other stuff. I used it once to move some furniture—big items like beds and mattresses. The center seat is simple to remove—but not particularly easy for one person, as it's not only heavy, but awkward. Get a helper and it's not bad. The rear seat takes some time to remove completely, so the drill here is simply to fold it down.

Our only real complaint about the MPV is the transmission, starting with the mushiest, vaguest column shifter in the industry. It gets the job done alright, but the sloppy feel is out of character with the quality of the rest of the car, er, truck.

There's a switch on the shifter for power or economy—we can't really detect any difference in driveability (which is not terrific), acceleration (which is terrific) or economy (which is about right for a vehicle of this weight at around 20 mpg highway). There's also a switch inscrutably labeled HOLD, which will make the electronically controlled transmission downshift a gear, sometimes, when you throw it. Even after we read the owner's manual, we couldn't figure out what it was for, so we ignored it.

In spite of the fact that the Pontiac Trans Sport we have now has a slightly larger engine, the MPV will leave it in the dust. All-in-all, now we understand why the MPV is the fastest-selling minivan. —Mike Allen

Mazda Miata

We'll bet that you still have yet to hear your first bad word about the Mazda Miata, and we absolutely *know* you're not going to hear it from us. At the end of its 1-year hitch in the PM long-term test fleet, our Miata is just as fault-free and fun to drive as it was on day one.

With 6752 miles on the clock, and an excellent all-around fuel economy performance of 28.2 mpg, our Miata has gone home. Its service has been superb, and the only complaint we've ever had about the design—the absence of an interior release for the trunk—is en route to a running change for future models.

As an all-around primary transportation car, the Miata is obviously limited by its size. It's a toy. But as an automotive entertainment value, the Miata stands alone. —Tony Swan

WOODWORKER'S MART

Power Saw Blades

● The designed purpose of a saw blade is often revealed by its teeth. Generally, the fewer teeth a saw blade has, the rougher it will cut. Conversely, for a smooth cut, use a saw blade with many teeth.

Saw blade teeth come ground in four common shapes: alternative top bevel (ATB), triple-chip grind (TCG), flat-top grind (FTG) and 4-tooth with raker. ATB teeth have very sharp alternating top bevels that sever wood easily and smoothly. ATB blades are often used for crosscutting and mitering. A TCG-saw blade is not quite as sharp as an ATB blade, but it holds its cutting edge longer. Therefore, it needs to be resharpened less often. TCG teeth produce a smooth-cutting, general-purpose blade that can rip and crosscut.

For fast, aggressive cutting, use an FTG blade. This heavy-duty tooth pattern is used primarily on rip blades. Flat-top teeth cut like tiny chisels.

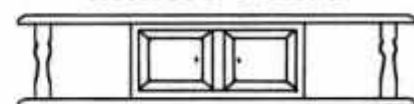
The 4-tooth-raker blade consists of two pairs of ATB teeth and one FTG raker. The ATB teeth sever the wood and the raker cleans out the serf. This type of tooth pattern is popular with combination blades.

Also, some blades have narrow expansion slots cut in their edges. Expansion slots allow the blade to expand slightly when it heats up. Otherwise, the blade would warp. The round hole at the end of each slot prevents stress cracks. A few blade manufacturers are using lasers to cut expansion slots. These super-narrow slots eliminate most of the noise caused by standard expansion slots.

Saw blades are most effective, and safest, when they're sharp. Replace a blade once it has become dull and never use a blade with cracked or chipped teeth. Store blades between pieces of cardboard to protect the teeth from damage. Whenever you're changing blades, it's very important to be sure that the saw is disconnected from the electrical outlet.

All saw blades have a maximum rpm rating. Never use a blade on a saw that exceeds the blade's rating. Be sure that all blade guards are in place and operating properly before using a saw. And, of course, always wear eye protection when operating any power equipment.

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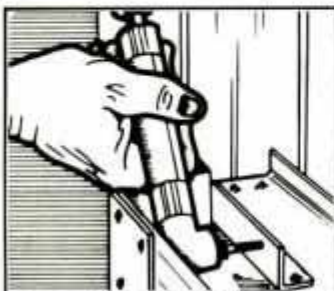
Finish Preparation

• The first step to wood finishing lies in proper surface preparation. This is especially true when using clear finishes since they won't hide minute scratches and nicks. In fact, a clear finish will often highlight surface defects as it accentuates the wood's grain.

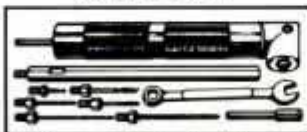
Fill small holes and gouges with wood putty (patching compound). Choose a putty color that matches the wood, but remember that the putty color will darken slightly when the finish is applied. Remove dried glue, scratches, tool marks and other minor surface imperfections with a hand or cabinet scraper and/or abrasive paper. Keep in mind that the finish will only be as smooth and level as the bare wood.

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Wood Screw Tips

● Wood screws are designated by length in inches, gauge number (shank diameter) and screwhead style, for example: 1 1/2-in. No. 8 fh (flathead) screw. The higher the gauge number, the larger the screw shank. However, each gauge number comes in several lengths. Therefore, a 1-in. No. 12 has a thicker shank than a 3-in. No. 8 screw. Wood screws are commonly available with flat-, round- and oval-heads in slotted, Phillips and Robertson styles. Also, screw lengths are measured from the screw tip to the part of the head that is flush with the wood. Measure a flathead screw to the top of the head. A roundhead screw is measured to the bottom surface of the head.

Whenever possible, screw through the inner piece of wood and into the thicker board. As a general rule, 2/3 of the screw's length should be driven into the thicker board. Here's the proper method of installing a wood screw. First, bore a pilot hole to a depth equal to about 3/4 of the screw length. The pilot hole must be slightly smaller in diameter than the threaded portion of the screw. Next, bore a screw-shank clearance hole through the first, thinner board only. Finally, countersink the hole.

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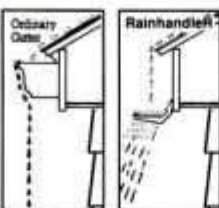
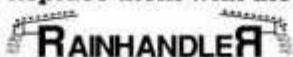
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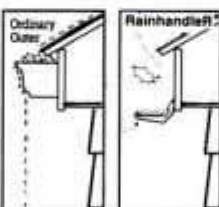
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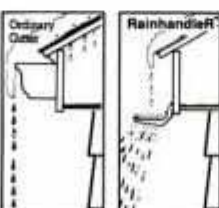
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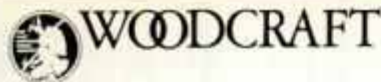
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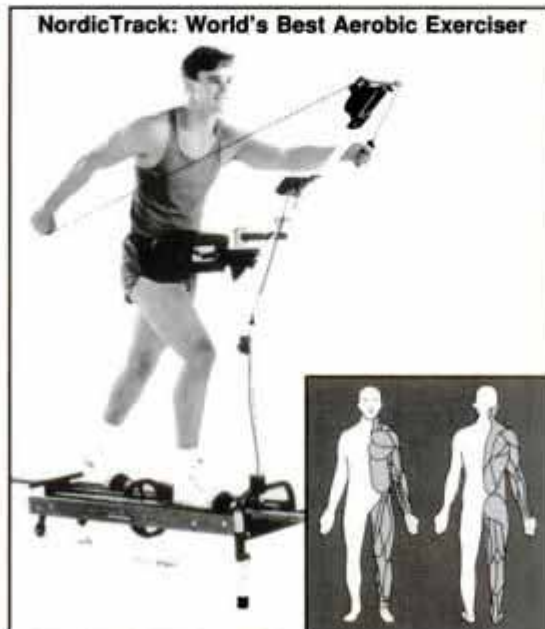
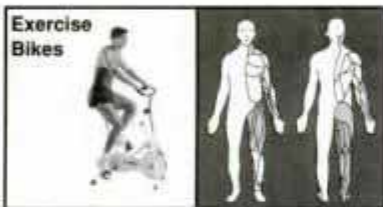
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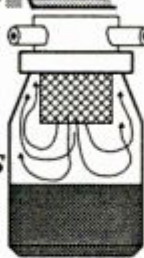
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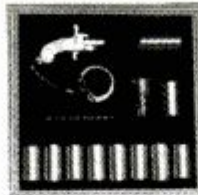
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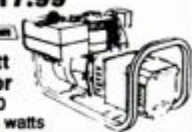
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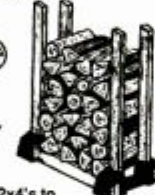
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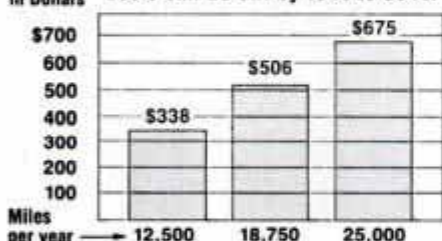
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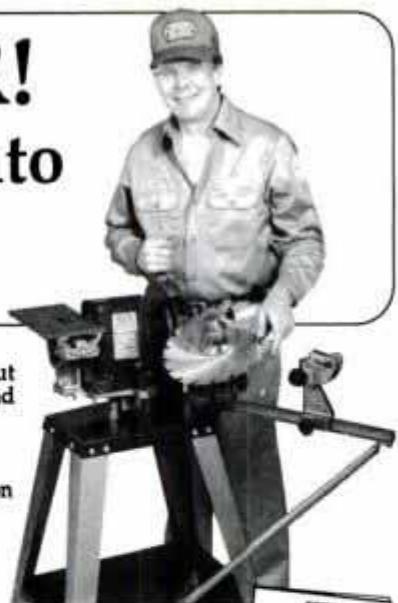
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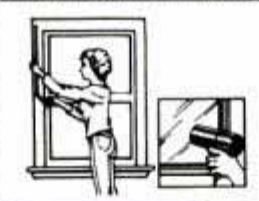


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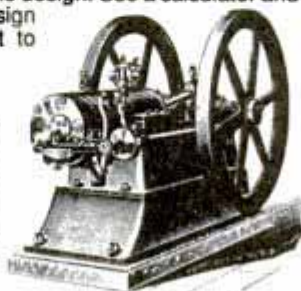
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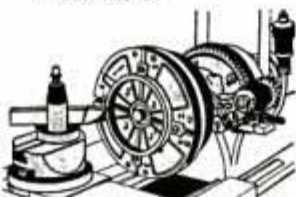
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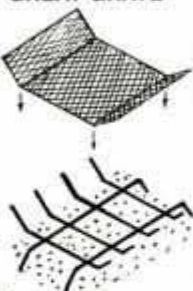
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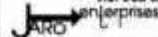
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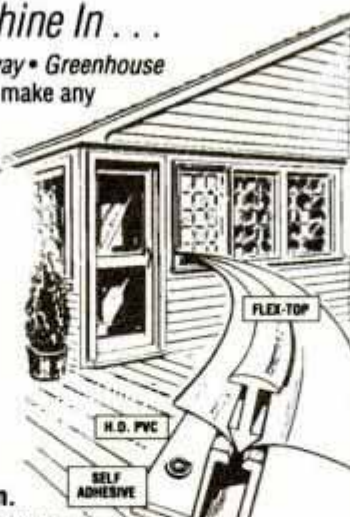
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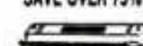
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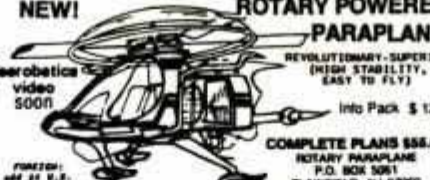
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